

Railway Mechanical Engineer

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ESTABLISHED IN 1832

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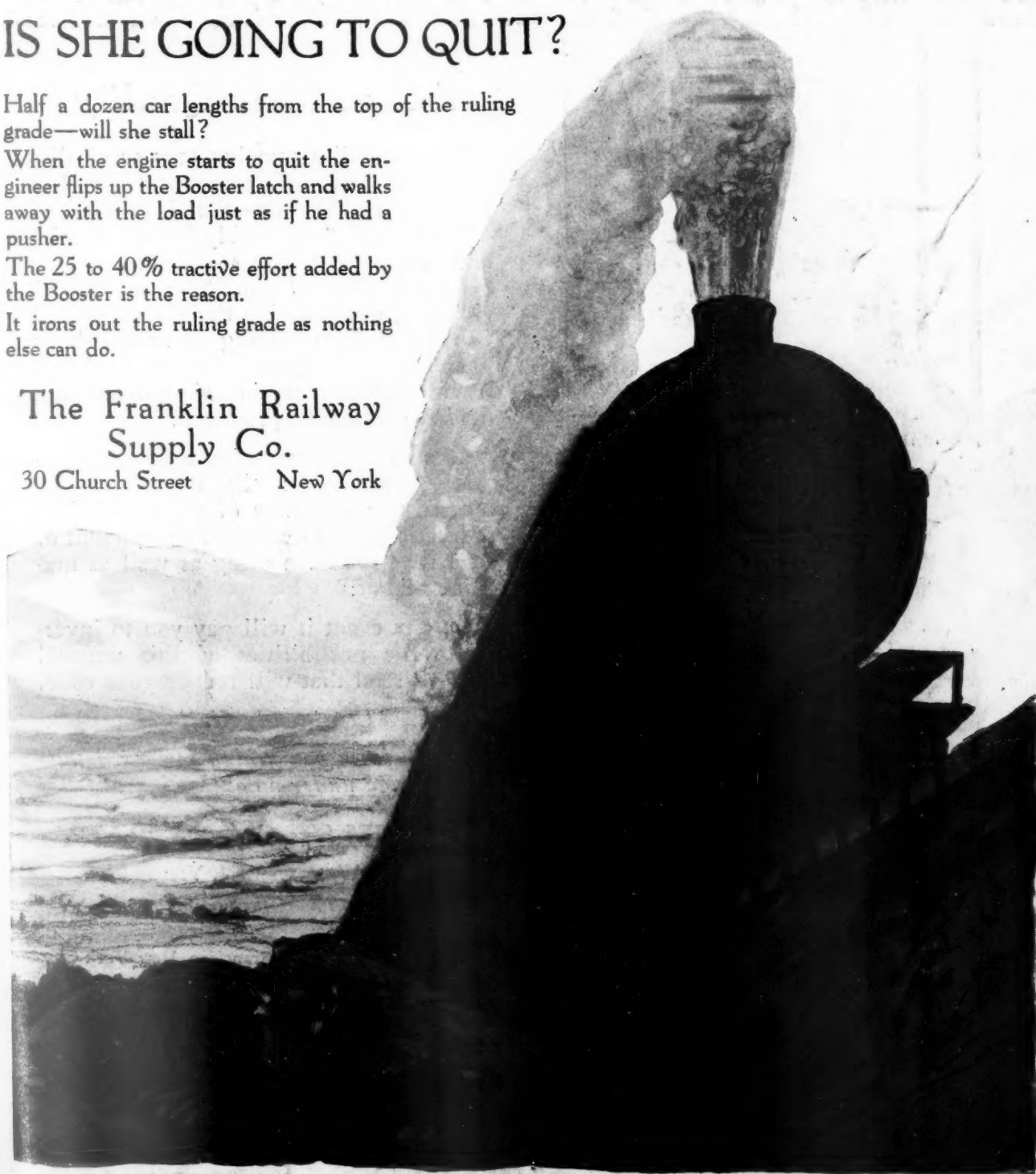
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Railway Mechanical Engineer

Volume 95

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The most momentous question of the day on the railroads is readjustment of working rules and wages. At present the

Are Wage Reductions Necessary?

question promises to revolve into a heated controversy. In discussing this matter it may be enlightening to depart somewhat from the evidence presented at Chicago and consider for a

moment the existing economic conditions to determine whether they indicate that a reduction in wages is justifiable or not.

No one will deny that there has been a serious slump in business all over the country. Factories are working intermittently; millions are idle. The number of cars loaded weekly has declined to 70 per cent of what it was last fall. For the week ending February 23 there were 423,193 cars standing idle. Economists are generally agreed as to the cause of the present depression. The international situation caused a sharp decline in the prices of farm products. Other prices did not drop at the same time. Therefore, after the decline the farmers' goods would purchase relatively a much smaller amount of other commodities. In other words, the purchasing power of the farmer had declined. Farmers form a very large proportion of the population and it is natural that when they curtail purchases, business should be bad. There are economic forces which, if allowed to operate normally, work out a natural balance between industries and occupations. That balance must be sustained in order that the products or services of each group may be absorbed by all the other groups. When the balance is lost, unemployment results and continues until a redistribution is worked

out so that everyone is at work and all products are absorbed.

The secret of prosperity is in balanced industry with the production of every branch of industry in proportion to the wants and buying power of the people in all other occupations. The number of people that can be employed in any industry depends on the demand for the product, which in turn depends on the price. If the price of a commodity is increased, the consumers will have to curtail their purchases of it, or of something else. Individuals or groups may fix prices or wages, but they cannot govern the effect their action will have upon sales. This is made very plain by present conditions. Dealers object to cutting prices and labor organizations object to reductions in wages. They have been successful in holding out, but their prices are too high for the farmers and business is stagnant because the adjustments necessary to restore equilibrium are not made. It is short-sighted to think that wages can be fixed under all conditions by agreement between employer and employee. There is a relationship between each industry and all other industries that must be taken into account. What is needed now is a readjustment of the relationship of prices of farm products with other prices and wages. It would be difficult, if not impossible, to control the international conditions that govern the prices of farm products in order to cause these prices to rise. The only other course that will restore the balance of industry is to bring other prices and wages down.

This is not an argument for reducing the wages of railroad employees only. Other wages and prices must come down also. Neither is it the intention to propose that the

reduction should be of the same magnitude as the drop in farm products. Nevertheless, it is worse than foolish—it is futile—for any group of employees to oppose a moderate reduction of wage rates. As the cost of living is declining a reduction at this time will be more apparent than real.

The modern industrial organization is dependent upon intelligent, voluntary and harmonious co-operation on the part of all the people. It requires that the people shall distribute themselves in the various industries and so direct their individual policies as to keep the industries in balance and effect a ready exchange of products. If through mistaken ideas of self-interest they organize themselves into groups and become so intent upon forwarding group interests that they lose sight of the necessity for general co-operation, the whole modern system of highly developed and highly specialized industry will break down.

It is well known that a country cannot expand commercially without adequate means of transportation. It is equally true

What Is the Other Fellow Doing?

that the industries of a country cannot grow in efficiency and economy without some method of spreading general knowledge regarding improved machinery and methods which have demonstrated their value. While in some respects railroad shops are decidedly different from manufacturing plants and are confronted by different problems, certain fundamental conditions and problems are the same. Among these is the absolute necessity of keeping in touch with late developments and practices which have proved big time and money savers. Mechanical department officers on the whole are awake to this necessity, and no new railroad repair shop is now constructed without first making a careful and detailed study of existing plants with the idea of incorporating all possible good features and avoiding bad ones. The annual June convention of the American Railway Association, Division 5—Mechanical—offers a wonderful opportunity for railroad men to interchange ideas and benefit by the inspiration which comes from contact with capable, experienced officers who daily meet the difficult problems arising in the repair and maintenance of cars and locomotives in a serviceable condition. The technical papers also afford a fine opportunity for careful readers to keep abreast of the times and in touch with the most modern, approved shop practices.

One avenue of information has been sadly neglected, however, due to the short-sighted policy of some roads in not allowing their gang leaders and foremen to visit other shops and attend conventions. For example, the leading tool maker of a large railroad shop desired to attend the convention of the American Society for Steel Treating held at Philadelphia last year. This man's service with the railroad had been entirely satisfactory and he desired to profit by the wealth of information on the heat treatment of high speed tool steel available at the convention. He was told that no expense money could be allowed but in spite of this fact attended the convention for two days, and returned to his position with definite information, the actual cash value of which to his company would be hard to estimate. It is true that this tool maker was furnished with transportation to and from the convention, but his hotel expenses were paid out of his own pocket and he was required to lose two days' pay for the time he was absent from the shop. Can there be any excuse for such a penny wise and pound foolish policy? It is recognized that owing to the magnitude of the railroad industry, indiscriminate traveling cannot be tolerated. There is no reason, however, why the prohibition of educational trips should be so hard and fast that ambitious workmen or foremen must be at a financial loss in acquiring information which may well mean thousands of dollars annual saving for the railroads with which they are connected.

The word obsolescence is defined as "the state of being out of date; disused." Unfortunately a large amount of the machinery and equipment used in railroad shops is obsolete to the extent that it has gone out of date and can no longer be efficiently operated. Even more unfortunate, however, is the fact

Machine Tool Obsolescence

that the second part of the definition does not apply since this machinery is now being used, no matter how uneconomically, and at a considerable cost for labor and delayed repair work. It may be dangerous to draw comparisons, but a prominent automobile manufacturer stated recently that he could not afford to operate machine tools, for example, after they are two years old. In this length of time they have earned their cost many times over and if not readily salable as second-hand tools, they are scrapped in favor of more efficient, productive types. Admitting the fundamental difference between railroad shops with diversified repair work and automobile plants manufacturing standard products, there is no reason why railroad shops should swing to the other extreme and be required to operate with machines indefinitely old. Two years is an extremely low estimate of the useful life of machine tools, but some reasonable period, as for example 10 years, should be decided on and used as a basis in accounting for depreciation. Developments in the design and improvement of machine tools are so rapid that most machines 10 years old are hopelessly out of date as production tools and can no longer be used economically in shops handling any considerable amount of work. Especially in the centralized production departments of railroad shops is it necessary and good economy to employ only modern, high capacity machines. Old machines should be retired and this can be accomplished by setting aside annually an amount of money equal to 10 per cent of the value of railway machine shop tools, charging it to the depreciation account. Then, at the end of the 10 years, it will be possible for the shops to benefit by the installation of new and improved machinery which is not held up due to difficulty in obtaining the necessary capital. The high cost of labor and the high cost of equipment held out of service, combined, make it imperative that obsolete machinery and shop tools be replaced as fast as possible by modern productive machinery.

There is one operation in setting locomotive valve gears which may be materially speeded up, especially in some shops, without in any way reducing the quality or accuracy of the work.

Save Time in Valve Setting

The operation referred to is revolving the main driving wheels in valve setting to obtain the dead centers, lead, cut-off and travel marks. In many shops the driving wheels are now revolved at a considerable expense of time and physical effort, the common method being to relieve the spring weight on the wheels as much as possible, apply rolls beneath them and draw the rolls together until the wheels just clear the rail. Hand operation of the rolls by a long handled ratchet revolves the wheels. The difficulty with this method is in the large amount of physical effort required to turn the rolls, which in many cases slip and do not make the wheels revolve. A considerable proportion, possibly 35 per cent, of the time required to set valves is now spent turning the driving wheels, and the remedy for this condition is rapid power revolution of the driving wheels in valve setting. In some cases, air motors have been applied to the rolls, thereby reducing materially the labor involved, but the results with this method have not been wholly satisfactory due to continued sticking and slipping of the wheels. Some device of greater power should be provided. It is possible to design a set of power driven rolls of rugged construction, sufficiently large in diameter to eliminate practically all slipping be-

tween the rolls and the driving wheels. An efficient form of drive for such a mechanism has already been devised in the application of an electric motor to a four-wheel truck, connected to the rolls by a powerful, universal joint. With the weight relieved from the main driving boxes and a sufficiently powerful motor to drive the rolls, no difficulty will be found in revolving the driving wheels. The time saved by rapid power revolution of driving wheels in valve setting is doubly important because it occurs during the last day or two the locomotive is held in the shop for repairs. The reduction of this time by one day for one locomotive would more than pay the cost of a set of new power rolls.

It would be difficult to conceive of circumstances more trying to the men in the car department than exist at this time.

An Eye to the Future

Ever since 1917 the problem of keeping equipment in condition has been a difficult one. The percentage of bad order cars has been high and freight cars have been used so intensively that little progress has been made in getting them repaired, except during a few short periods of light traffic. Now that cars are being returned to the owning roads and large numbers are idle, the conditions are favorable for doing a good deal of repair work, but the critical financial situation of many of the railroads makes this impossible. Cars reaching the home road are merely being set aside and bad orders are steadily increasing. The number of unserviceable cars on March 23 was 459,411, the highest figure ever recorded.

There is no question that immediate economies are called for, but it would be a mistake to allow this to interfere with the problem of future repairs. The cost of almost any work can be materially reduced if it is carefully planned in advance. In car work there has been too much of a tendency to leave the decision as to how to handle the job to the repairman. This has resulted in costly methods of doing work without efficient specialized equipment. Furthermore, it has led to waste through repeated replacement in kind of parts that should have been strengthened. This is an opportune time to lay plans for correcting wrong conditions. As cars are bad ordered, they should be carefully inspected with the ideas mentioned above in mind. If a large number of one class need heavy repairs, a schedule for handling the work can be outlined. By obtaining material in advance and systematizing the operations, work can be greatly expedited.

Some classes of cars are continual sources of trouble, and under normal conditions would have been retired without question. There has developed in recent years a practice of keeping cars in service almost irrespective of the amount of repairs required, though this is in many cases the costliest policy that could be followed. The old equipment of low capacity often shows a high repair cost per car. If the figure is changed to the cost per ton of capacity, it is still higher, and if it could be ascertained on the basis of the ton mile, it would probably be startling. This is the measure that should be applied when deciding what cars are not economical to repair. Traffic is certain to increase again, and when that time comes the roads cannot afford to put up with the interruptions to traffic and the handicap to the shops that would result from keeping a large number of old, weak cars in service.

THE TEMPERATURE AT WHICH carburizing should be carried out should be just above the critical temperature of the steel, or 1650 deg. F., generally speaking. To operate at a lower temperature will decrease the rate of penetration, thus increasing the cost, and to operate at a very much higher temperature will not only produce a very high carbon surface with its tendency to crack and peel, but may burn the pieces beyond reclaiming. Correct known temperatures are essential to success.—*The Melting Pot.*

COMMUNICATIONS

Selecting Foremen

WASHINGTON, D. C.

TO THE EDITOR:

In the March number of the *Railway Mechanical Engineer*, views are asked as to what training a foreman should have. When this was read a man of wide railroad experience happened to be near and he was asked the question as to what is necessary to make a good foreman. The answer came, quick as a flash, "They can't be made." "You mean they have to be born?" "Yes," was the answer.

This question of foremen is one that all of us have given considerable thought ever since the day we were trying to determine the requisites in order to qualify ourselves for a foreman's job. There is more truth than poetry in the statement that foremen have to be born, but it is really only a half truth, as numbers of men have been made, some actually hand-molded. What, then, is necessary—can the points be defined—is it possible to take a man's measure and determine accurately whether he is a potential official?

In the "box" calling for views on this subject, the statement is made that as a rule the best mechanics are selected for minor officials. If this rule were followed blindly, we would soon be shipwrecked, as it has nothing whatever to do with a man's capacity to accept and profit by advancement and should be only incidental.

It is necessary to study a man for some time to determine his capabilities. First, is he honest in every way? Second, is he substantial, that is, dependable in an all around and general way? Next, is he subject to the influence of other men in the shop; is he prejudiced or narrow-minded? Who are his associates and what does he do with his spare time? Is he ambitious and does he feel that railroading offers ample opportunities to make him anxious to make it his life work? Does or can he exert good influence over men, and can he talk forcibly—to the point and with conviction when necessary? Will he study his job and endeavor to perfect himself in the profession, realizing that there are many angles to it and many units that go to make up the whole? Last but not least, can he control himself and thus permit his mind to function properly in times of dire stress or emergency?

Human nature is the same yesterday, today and tomorrow, but there is too much loose talk going the rounds about men having no ambition and about it being well nigh impossible to recruit the quota of minor officials. Because you "happen" to pick out four or five men and ask them how they would like to take Jim Jones' place and they state that they would prefer to remain in the ranks, it does not follow that such a conclusion is correct. The trouble is really with the management, for a live organization will assure itself at all times of sufficient potential officials, as otherwise it will deteriorate and eventually fail. We anticipate our needs on other scores and must do so for future foremen. It has been truly said many times and in many ways that the foreman is the life blood, if not the mechanical department itself, to all intent and purposes.

If a higher official asks a master mechanic for a man to go to another division for promotion and he has none available, it is an admission on his part that he is not anticipating or planning for the future, and therefore that little can be expected from him as far as better results are concerned. He should be glad, if it were possible, to train men for the whole system and take pride in and profit by their success. It is worth while to be able to pick a winner and the best training obtainable is by teaching others.

The master mechanic dictates the policy of his shop, his

subordinates execute it, therefore the most important item of all—choosing and making the subordinates—should be the master mechanic's particular duty. The general foreman should, of course, be consulted, but he should not select the men alone. This is a tedious operation requiring the highest skill, and the highest official, who is supposed to be the most skilled, should perform the task. Letting general foremen and roundhouse foremen select their subordinates invariably tends to stabilize or deteriorate the quality of the foremen, whereas if the higher official selects them, the quality should be persistently improved. From another angle, where various men handle this operation uniformity is not secured, while if the master mechanic selects them all, by and with the advice of his subordinates, uniform results will be obtained, mistakes in analysis can be more readily determined and guarded against.

As a concrete example the master mechanic says, "Mr. General Foreman, I want you to consult your subordinates, study and observe the workmen and give me the names of four men for prospective machine shop foremen, four for roundhouse foremen, two for boiler foremen and two for general foremen. I will then acquaint myself with these men in order to determine if they will prepare themselves, in anticipation of promotion. Give this matter mature thought for I will not approve your recommendations without personal investigation in each case and I am determined to have sufficient supervisory material in the making to fill all needs." A little talk with these men, after due deliberation and observation, should encourage them to make ready for promotion, and if their enthusiasm is aroused they will make good. Impress upon these men the required fundamentals, get them to thinking and planning and enthusing, tell them that their ability must grow if they expect it to bring more money each year, encourage them to consult with and study their superiors and invite them to attend a staff meeting from time to time. They can use their imagination and be acquiring skill as a supervisor so that there will be no question about their making good when their time for promotion comes.

JOHN MITCHELL.

NEW BOOKS

The Welding Encyclopedia. Compiled and edited by L. B. MacKenzie and H. S. Card, editors of the *Welding Engineer*, 336 pages, 6 in. by 9 in., illustrated. Bound in cloth. Published by the *Welding Engineer Publishing Company*, 608 South Dearborn street, Chicago.

The development of fusion welding processes and the rapid extension of their application in industry during the past decade has created a field which is now becoming highly specialized. Although several books have been published dealing with various phases of welding, the greater part of the literature on the subject is not available to the practical welder for the reason that it is widely scattered through periodical publications dealing primarily with other matters. The *Welding Encyclopedia* brings together in one volume a wide range of knowledge concerning welding practice, equipment and auxiliary appliances for all classes of work. About one-third of the subject matter is an illustrated definition section in which all words, terms, and trade names used in the welding trade are defined. Short treatises are included in this section on a number of the more important topics and it also serves as an index to the subject matter in the special chapters on the oxy-acetylene, electric arc, electric resistance and Thermit processes, the use and care of equipment, boiler welding, and the heat treatment of steels, which follow the definition section. A valuable feature of the book is the section on Rules and Regulations, which contains a compila-

tion of the various codes of rules applying to fusion welding. These include the A. S. M. E. boiler code, the regulations of the Department of Commerce Steamboat Inspection Service, Lloyd's Register of Shipping, the Underwriters' Laboratory, the National Board of Fire Underwriters, the American Railway Association (M. C. B.), and the Interstate Commerce Commission specifications for gas shipping containers. The status of welding regulations in the various states is briefly summarized and where specific regulations have been developed these are given. There is also a catalogue section in which are described equipment, materials and supplies sold commercially for use in welding. The book forms a valuable reference work from which the practical welder may obtain much fundamental knowledge of correct practices for a wide range of work, and to which the general reader may refer for the meaning of terms and for a knowledge of the status of the different branches of the art.

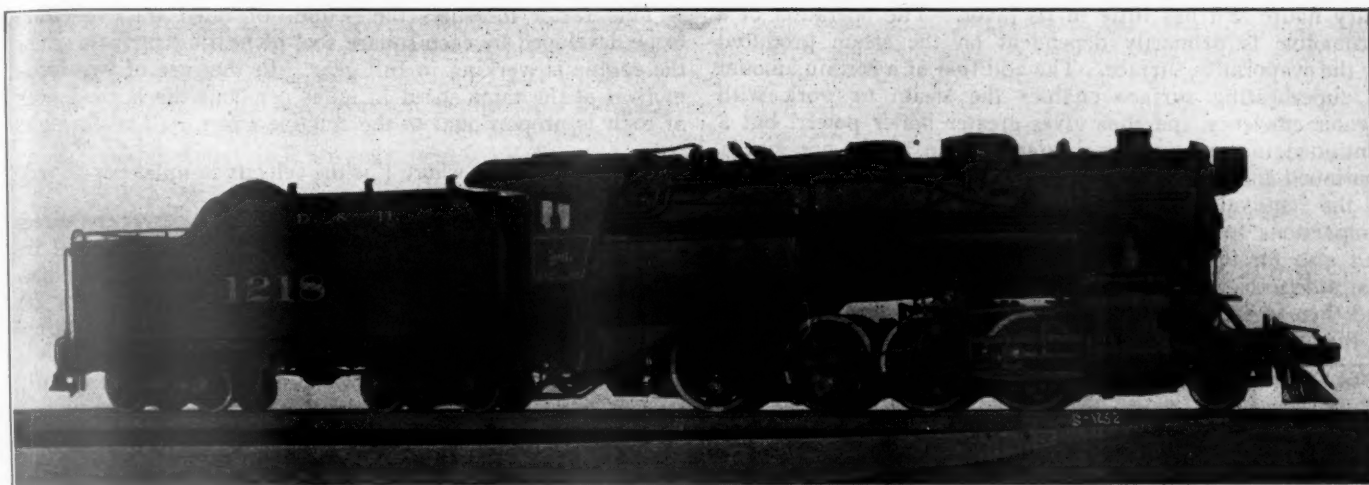
Steam Locomotives of the Present Time (Die Dampflokomotiven der Gegenwart). By Robert Garbe, 7½ in. by 10½ in., illustrated. Volume 1, 859 pages; volume 2, 54 lithographed tables and drawings. Published by Julius Springer, Linkstrasse 23, Berlin W. 9, Germany.

This is a second edition of this well-known work originally published in 1907. The text has been brought up to date and an attempt has been made to present the same well-rounded survey of locomotive development in all countries that was given in the earlier work. Apparently the war interfered with the compilation of data and some parts of the book are unfortunately incomplete.

The book opens with an historical sketch of the use of highly superheated steam in locomotives and a discussion of the essential progress in locomotive building in the past 20 years. The first chapter deals with superheat as a working medium, the question being discussed largely from the theoretical viewpoint. The succeeding chapters are devoted to the calculation of the main dimensions of superheated steam locomotives, two-cylinder and multi-cylinder locomotives with simple and double expansion and the uniflow engine of which a rather extended discussion is given. Various types of superheaters are described and noteworthy structural details of more recent locomotives are discussed. A section is devoted to the latest developments in feed water heating. The superheated steam locomotives of the Prussian State Railways are described and the section following is devoted to superheated locomotives of various railroads in countries other than Germany. The American locomotives are described in this and in a previous chapter but the types shown cannot be classed as typical examples of the latest developments in motive power in this country. The results of numerous tests of superheated steam locomotives, principally in Germany, are set forth and it is notable that these are nearly all from seven to ten years old. The concluding chapters deal with details of design and operating methods.

Apparently the principal shortcoming of the book is the lack of complete and up-to-date information concerning the locomotives built by the allied countries. This, however, is not of primary importance as American readers would be chiefly interested in the book for the information they might obtain regarding the progress that has been made in Germany in the years during which communication was interrupted. Apparently the descriptions of German motive power have been given painstaking attention and the work of German designers during and since the war, is here presented for inspection for the first time.

IN BORING SHEET BRASS it is a good idea to place a piece of hard wood behind the piece being drilled.—*The Melting Pot.*



Delaware & Hudson Heavy Consolidation Locomotive.

Notes on the Comparison of Locomotive Dimensions

Significance of the Principal Factors, Their Application in Designing and Values for Various Types

BY LAWFORD H. FRY
Standard Steel Works Co.

For a number of years past the *Railway Mechanical Engineer* has published lists of dimensions, weights and ratios in connection with the descriptions of new locomotives. It is felt that in view of the many new developments in recent years, the data furnished does not meet the present requirements. It has been decided to revise the form of tabulation hitherto used and in order that the new form should represent the best practice, suggestions have been invited from a number of authorities on locomotive design. The paper by Mr. Fry, presented below, is the first contribution on this subject. Others will appear in later issues.—EDITOR.

IN passing judgment on a locomotive design, attention must be given not only to the dimensions but to the proportion in which these stand to each other. These proportions are conveniently measured by the factors discussed below. Before entering the discussion it is well to note that the proportion between the dimensions is more conveniently expressed as a "factor" than as a "ratio." It must be remembered that a ratio must be expressed as the relation of one number to another and not as a single number. For example, if a locomotive with 202,000 lb. on drivers has a rated tractive effort of 45,000 lb. we may say that the ratio of adhesion is 4.1 to 1 or that the factor of adhesion is 4.1. The latter form of expression is the more convenient.

It is also convenient to give each factor a name and to designate each by a definite letter; thus (A) for the Factor of Adhesion, (B) for the Boiler Factor, and so on, as shown below.

Factors

The most important factors in common use are:

$$A = \text{Factor of Adhesion} = \frac{\text{adhesive weight}}{\text{rated tractive effort}}$$

$$B = \text{Boiler Factor} = \frac{\text{rated tractive effort}}{\text{evaporative heating surface}}$$

$$C = \text{Combustion Factor} = \frac{\text{evaporative heating surface}}{\text{grate area}}$$

$$BD = \text{Boiler Demand Factor} = \frac{\text{rated tractive effort} \times \text{driving wheel diameter}}{\text{evaporative heating surface}}$$

$$E = \text{Factor of Efficiency of Design} = \frac{\text{total weight}}{\text{evaporative heating surface}}$$

Sh/S = Superheater surface as percent of evaporative heating surface.

Before considering the factors in detail two of the dimensions entering into them require attention. These are the tractive effort and the heating surface. The rated tractive effort (R.T.E.) is computed from the well known formula

$$R.T.E. = \left(\frac{0.85 d^2 s P}{D} \right) \text{ where } d \text{ is the cylinder diameter, } s \text{ the}$$

stroke and D the driving wheel diameter, all in inches, while P is the boiler pressure in pounds per square inch. The force thus computed is the maximum tractive force deliverable by the cylinders at the rim of the drivers if the cut-off is long enough to give 92 per cent of the boiler pressure as mean effective pressure, and if the machine friction absorbs about 8 per cent of the indicated cylinder power ($0.92 \times 0.92 = 0.85$ nearly). Even though these assumptions do not hold exactly, it is desirable to use the factor 0.85 in all cases so that the rated tractive effort is a definite measure of those dimensions of the cylinders, drivers and steam pressure which determine the tractive force.

The heating surface used in computing the factors is the total evaporative heating surface made up of the firebox, tube and flue heating surfaces, the superheating surface being left for separate consideration. Considerable use has been made of the so-called "equivalent heating surface" which is taken to be the evaporative surface plus 1.5 times the superheating surface. This is, however, a purely arbitrary

trary figure and has little in its favor. The operation of a locomotive is primarily dependent on the steam produced by the evaporative surface. The addition of a certain amount of superheating surface enables the steam to work with greater efficiency and thus gives greater boiler power, but a continued increase in superheater surface would not give a continued increase in boiler power in the manner indicated by the "equivalent heating surface." To secure satisfactory comparisons for the steam producing capacity of the boiler and also for the added efficiency due to superheating, it is desirable to base the boiler factors on the evaporative surface and then to express the superheating surface as a percentage of the evaporative surface.

TABLE 1—AVERAGE VALUES OF VARIOUS FACTORS FOR DIFFERENT LOCOMOTIVE TYPES

1	2	3	4	5	6	7	8	9	10
Reference to table of dimensions	Type	Steam	Date	No. of locos.	Adhesive wt. Rated trac. effort	Rated trac. effort Evap. heat. surf.	Rated trac. eff. x D Evap. heat. surf.	Total weight Evap. heat. surf.	Superheating Surface as % of Evap. heat. surf.
.....	4-6-0	Sat.	1910	11	4.6	10.7	720	66	....
.....	4-6-0	Suph.	1910	3	4.3	13.9	990	80	16.9
Table 2...	4-6-0	Suph.	1920	3	5.0	13.5	950	87	20.6
.....	4-6-2	Sat.	1910	31	4.3	9.0	620	61	....
.....	4-6-2	Suph.	1910	8	4.5	11.2	800	73	24.1
Table 3...	4-6-2	Suph.	1920	28	4.3	11.5	840	76	22.9
Table 4...	4-8-2	Suph.	1920	10	4.3	12.6	860	80	23.5
.....	2-8-0	Sat.	1910	21	4.3	13.7	800	66	....
Table 5...	2-8-0	Suph.	1920	16	4.1	17.8	1,015	82	21.4
Table 6...	2-8-2	Suph.	1920	28	4.1	14.1	870	75	22.8
Table 7...	2-10-2	Suph.	1920	12	4.2	15.0	920	78	24.0

Average values of the various factors are given in Table 1. These represent 161 locomotives of the types most in use at present for main line service. The values given under date of 1910 are taken from an earlier compilation made by the writer (The Engineer, Oct. 13, 1911), while those under date of 1920 are from Tables 2 to 7 herewith. The latter are all modern locomotives, the majority having been put into service between 1915 and 1920, and all use superheated steam.

Factor of Adhesion

$$A = \frac{\text{Adhesive Weight}}{\text{Rated Tractive Effort}}$$

The value of this factor shows the weight holding the wheels to the rail for each pound of average force tending to rotate them, and therefore measures the ability of the engine to start without slipping. In considering this it must be remembered that the force developed by the cylinders varies throughout the stroke, the value given by the formula for rated tractive effort being the average value, while the maximum value is about 20 per cent higher. With a clean dry rail slippage will not be likely to occur so long as this maximum value of the tractive force does not exceed 30 per cent of the weight on drivers, that is so long as the average value, the rated tractive effort, does not exceed 25 per cent of the weight on drivers. In other words, if A , the Factor of Adhesion, has a value of 4.0 or more the locomotive is not likely to be slippery on starting.

Column 6 of Table 1 shows average values of the factor A for various types of locomotives. It will be seen that the modern locomotives are quite uniform in having values from 4.1 to 4.3 on the average. The tendency is for the heavy drag types such as the 2-8-2 and 2-10-2 to have the lower values; that is, for these engines to have cylinders of a size to fully utilize all of the adhesive weight.

Boiler Factor

$$B = \frac{\text{Rated Tractive Effort}}{\text{Evaporative Heating Surface}}$$

This factor measures the pounds of rated tractive effort to be developed by each square foot of heating surface, when the engine is working in full gear. In the case of two locomotives at the same speed in miles per hour the horse-power of each is proportional to the tractive effort. (The formula

$$\text{is H.P.} = \frac{T.V.}{375}, \text{ where } V \text{ is the velocity in miles per hour.})$$

Therefore under these conditions the horse-power required from each square foot of heating surface is proportional in each case to the value of the factor B . If one engine has $B = 10$ and the other $B = 12$ the latter is calling for 20 per cent more power from each square foot of heating surface.

It may be taken that at slow speeds with engines in full gear, a horse-power can be developed from 3.0 sq. ft. of heating surface in a saturated steam locomotive and from 2.5 sq. ft. in a superheated locomotive. On this basis the maximum speed in miles per hour at which the full rated

tractive effort can be developed will be $V = \frac{125}{B}$ for satur-

ated and $V = \frac{150}{B}$ for superheated locomotives.

Boiler Demand Factor

$$BD = \frac{\text{Rated Tractive Effort} \times \text{Driving Wheel Diameter}}{\text{Evaporative Heating Surface}}$$

This is simply the boiler factor B multiplied by the driving wheel diameter, D . With the engine in full gear, the factor BD is proportional to the foot-pounds of work done during each revolution for each square foot of heating surface. It is evident that both the B factor and the BD factor measure the relation between the cylinder and boiler dimensions, that is between the steam consuming and the steam producing parts of the locomotive. The difference between the two factors is shown in the following definitions:

When two locomotives are both developing their full rated tractive effort, or are both developing the same percentage of their rated tractive effort, the amount of horse-power to be supplied by each square foot of heating surface is proportional, for each locomotive, to the factor B when the speeds are the same in miles per hour, and is proportional to the factor BD when the speeds are the same in revolutions per minute. It is obvious that if two engines have the same driving wheel diameter, they will show the same relationship whether compared by their B or by their BD factors. The difference comes when two engines of the same type and designed for the same number of revolutions per minute are intended to work at different speeds in miles per hour and have driving wheel diameters in proportion to these working speeds. If both locomotives are well proportioned they will have approximately the same value of BD , while the slower speed engine will have a correspondingly larger value of B . The BD factor is therefore a better measure of the basic proportions of the locomotive.

Values of the factors B and BD from columns 7 and 8 of Table 1 show the following average values for modern super-heater locomotives:

Type	B	BD	D
4-6-2	11.5	840	73 in.
4-8-2	12.6	860	68 in.
2-8-2	14.1	870	62 in.
2-10-2	15.0	920	62 in.
2-8-0	17.8	1015	57 in.

These figures show that the 4-6-2, 4-8-2 and 2-8-2 types have very similar values of BD , the averages running from 840 to 870, while the values of the factor B increase as the driving wheel diameter is decreased. With the 2-10-2 and 2-8-0 types the tractive power stands in a larger proportion to the heating surface, as shown by the larger values of BD . The fact of course is, that these types having a large propor-

tion of their weight on driving wheels, offer more opportunity for providing large cylinders and less for providing heating surface. The larger values of *BD* show that they are adapted for lower speeds in revolutions per minute, while the proportionately still larger values of *B* (due to smaller driver diameters) indicate considerably lower speeds in miles per hour.

For a comparison between saturated and superheated steam the following figures are taken from Table 1 for the Pacific type (4-6-2) and the Consolidation (2-8-0) which are the

only two classes appearing in the older saturated class and also among the more modern superheaters.

	B	BD	D
4-6-2 Superheated	11.5	860	73 in.
4-6-2 Saturated	9.0	620	69 in.
Difference as percent of value for superheated engine	22 per cent	28 per cent	
2-8-0 Superheated	17.8	1015	57 in.
2-8-0 Saturated	13.7	800	58 in.
Difference as percent of value for superheated engine	23 per cent	21 per cent	

The indication is that when saturated steam is used the boiler

FACTORS FOR INDIVIDUAL LOCOMOTIVES OF VARIOUS TYPES

TABLE 2—TEN WHEEL TYPE, 4-6-0

Road	Total weight Lb. Wt.	Adhesive weight Lb. Wa.	Cylinder diameter and stroke In. dxs	Driving wheel diameter In. D	Boiler pressure Lb. sq. in. P	Rated tractive effort Lb. T	Evaporative heating surface Sq. ft. S	Grate area Sq. ft. R	Superheating surface Sq. ft. Sh	Adhesive wt. Rat. trac. eff. A	Rat. trac. eff. Evap. surf. B	Evap. heat. surf. Grate area C	R. T. E. x D. Evap. heat. surf. BD	Total weight Evap. heat. surf. E	Superheating surf. as per cent of evap. surf. Sh/S
St. L. S. W.	209,400	165,200	22x28	69	185	33,400	2,474	49.6	532	5.0	13.5	49.8	930	84.8	21.6
Ga. S. & F.	192,300	147,200	21x28	68	200	31,000	2,268	49.0	462	4.8	13.6	46.4	980	85.0	20.4
Gen. Ver.	189,000	141,000	20x28	69	200	27,600	2,053	53.4	404	5.1	13.5	38.5	930	92.5	19.7
Average	197,000	151,000	.....	69	195	31,700	2,270	....	466	5.0	13.5	....	946	87.4	20.6

TABLE 3—PACIFIC TYPE, 4-6-2

L. V.	311,900	204,600	27x28	73	205	48,600	4,116	95.21	980	4.2	11.8	43.3	860	71.3	23.6
P. R. R.*	308,900	201,800	27x28	80	205	44,500	4,035	70.0	1,155	4.5	11.0	57.5	880	76.5	28.7
Erie	306,000	197,000	27x28	79	200	43,800	3,824	70.8	880	4.5	11.4	55.5	905	78.0	22.5
D. L. & W.	305,500	192,200	27x28	73	200	47,500	3,680	91.3	760	4.1	12.9	40.3	940	83.0	20.7
Pa. Lines	302,000	193,000	26x26	80	205	38,250	3,680	55.4	845	5.1	10.4	76.5	830	82.0	23.0
L. V.	301,500	192,200	27x28	73	205	48,800	4,103	75.0	980	3.9	11.9	54.8	870	73.5	23.9
A. T. & S. F.	300,950	180,000	25x28	73	200	40,800	4,110	66.5	942	4.4	9.9	62.0	725	73.1	22.9
St. L. S. F.	296,000	191,000	26 1/2 x 28	73	200	45,800	4,200	63.5	996	4.2	10.9	66.2	795	70.5	23.8
R. F. & P.	293,000	188,000	26x28	68	200	47,300	4,205	66.7	975	4.0	11.2	63.0	765	69.6	23.2
C. R. R. N. J.	291,400	181,400	26x28	79	210	42,800	3,757	94.8	816	4.2	11.4	39.8	900	78.2	21.6
Monon	285,000	179,000	26x28	73	190	41,900	4,048	62.6	935	4.3	10.3	64.4	755	70.5	23.1
C. C. & O.	283,000	177,000	25x30	69	200	46,000	3,982	53.8	955	3.8	11.6	74.2	800	70.5	24.0
†B. & O.	275,800	167,000	25x28	73	200	40,700	3,341	66.7	794	4.1	12.2	50.0	890	83.0	23.8
T. & P.	275,100	173,400	26x28	73	185	40,900	3,780	59.6	844	4.3	10.8	63.4	790	72.8	22.3
M. K. T.	272,000	165,000	25x28	73	200	40,700	3,838	57.5	870	4.0	10.6	67.0	770	71.0	22.7
N. Y. C.	269,400	171,300	23 1/2 x 26	79	200	30,900	3,427	56.5	803	5.6	11.1	60.6	875	78.5	23.4
C. B. & O.	269,200	171,300	27x28	74	180	42,200	3,364	58.7	751	4.1	12.5	57.5	930	80.0	21.3
N. Y. N. H. & H.	266,000	165,000	26x28	79	200	40,800	3,315	59.2	776	4.0	12.3	56.0	970	80.5	22.7
C. G. W.	257,000	152,400	25x28	73	190	38,700	3,732	56.0	794	3.9	10.4	66.8	755	69.0	21.3
G. N. R.	251,200	150,700	23 1/2 x 30	73	210	40,500	3,076	53.3	640	3.5	13.2	57.8	960	82.0	20.8
N. & W.	249,300	163,900	22 1/2 x 28	70	200	34,400	3,359	44.7	756	4.8	10.2	75.0	720	74.0	22.6
N. Y. N. H. & H.	246,200	153,100	24x28	79	200	34,800	3,355	53.5	730	4.4	10.4	63.0	820	73.5	21.8
A. C. L.	243,900	151,000	23x28	68	200	37,000	3,345	56.5	792	4.1	11.0	59.2	750	73.0	23.7
C. of Ga.	228,600	138,000	23x28	69	190	34,700	2,689	50.6	605	4.0	12.9	53.0	890	85.0	27.5
G. T. R.	224,000	146,700	23x28	69	185	33,800	2,826	50.6	592	4.3	12.0	55.9	825	79.4	21.0
N. C. & St. L.	219,550	143,500	23x28	69	185	33,800	2,891	52.4	592	4.3	11.8	55.2	805	75.8	20.8
N. O. & N. F.	206,700	130,500	22x28	68	200	33,900	2,573	46.0	546	3.9	13.2	56.0	900	80.5	21.2
M. R. & B. T.	190,500	123,400	21x26	64	190	29,000	2,417	44.3	558	4.3	12.0	54.5	765	79.0	23.0
Average	268,000	169,000	.....	73	197	40,300	3,540	....	810	4.3	11.5	....	835	76.0	22.9

*U. S. R. A., 4-6-2 B. †U. S. R. A., 4-6-2 A.

TABLE 4—MOUNTAIN TYPE, 4-8-2

A. T. & S. F.	367,700	243,100	28x28	69	200	54,100	4,802	71.5	1,086	4.5	11.3	67.1	780	76.5	22.6
*C. & O.	352,000	243,000	28x30	69	200	58,000	4,662	76.3	1,078	4.3	12.2	61.1	843	75.5	23.2
N. Y. C.	343,000	234,000	28x28	69	185	50,000	4,430	66.8	1,212	4.7	11.3	66.2	780	77.5	27.4
N. & W.	341,000	236,000	29x28	70	200	57,200	3,984	80.3	882	4.1	14.3	49.5	1,010	85.5	22.1
R. I.	337,000	224,000	28x28	69	185	50,000	4,117	62.7	944	4.5	12.1	65.8	840	61.0	22.9
*S. Ry.	327,000	224,500	27x30	69	200	53,900	4,121	70.8	957	4.2	13.1	58.3	905	79.3	23.2
G. N. R.	326,000	218,000	28x32	62	180	61,900	4,540	78.0	1,075	3.5	13.6	58.1	840	72.0	23.7
S. A. L.	316,000	210,500	27x28	69	190	47,800	3,715	66.7	865	4.4	12.9	55.6	890	85.0	23.3
So. Ry.	314,800	209,800	27x28	69	190	47,800	3,668	66.7	942	4.4	13.0	55.0	900	85.5	25.7
C. P. R.	286,000	192,000	23 1/2 x 32	70	200	42,900	3,667	59.6	760	4.5	11.7	61.5	615	78.0	80.7
Average	330,700	223,500	.....	69	193	52,400	4,170	....	980	4.3	12.6	....	860	79.6	23.5

*U. S. R. A., 4-8-2-B. †U. S. R. A., 4-8-2-A.

TYPE 5—CONSOLIDATION TYPE, 2-8-0

D. & H.	293,000	267,500	27x32	63	195	61,400	3,814	99.8	793	4.3	16.1	38.2	1,120	88.2	21.8
L. S. & I.	268,000	238,000	26x30	57	185	55,900	3,643	57.7	844	4.2	15.3	63.1	870	73.5	23.2
W. & L. E.	266,500	236,000	26x30	57	185	55,900	3,517	66.8	774	4.2	15.9	52.7	905	76.0	22.0
Pa. Lines	249,500	226,900	26x28	62	205	53,000	3,016	55.0	623	4.3	17.6	54.8	1,090	83.0	20.7
D. T. & I.	245,000	220,000	25x30	52	200	61,300	3,302	61.3	723	3.6	18.5	54.0	965	74.0	21.9
W. Md.	244,500	217,500	25x30	51	200	62,500	3,148	61.3	594	3.5	19.8	51.5	1,020	77.8	18.8
K. & M.	239,500	209,500	25x30	57	180	50,400	3,153	55.0	633	4.1	16.0	57.5	910	76.0	20.0
Interstate	222,600	192,200	25x32	61	180	50,000	2,951	54.0	646	3.8	17.0	54.6	1,035	75.5	21.9
B. & M.	211,000	186,000	24x30	61	180	43,400	2,392	53.4	522	4.3	18.3	45.0	1,120	88.2	21.8
Toledo Ter.	198,000	176,000	22x28	51	175	39,500	2,425	54.5	499	4.4	16.3	44.5	830	81.5	20.9
St. L. S. W.	232,800	202,300	25x30	61	190	49,600	2,800	52.5	591	4.1	17.7	53.4	1,080	83.0	21.2
D. & T. S. L.	215,200	190,000	23x30	63	180	38,500	2,355	50.6	450	5.0	16.4	46.5	1,030	91.0	19.1
S. & N. Y.	212,900	195,400	23x28	51	185	45,500	2,726	49.5	626	4.3	16.6	55.4	850	77.9	22.8
C. & C.	198,800	176,000	23x28	52	190	46,000	2,473	52.3	526	3.8	18.6	49.2	970	80.5	21.3
P. & R.	281,100	250,800	25x32	55 1/2	200	61,260	2,655	54.9	575	4.1	23.0	27.0	1,280	94.5	21.6
Union	260,300	240,300	25x32	55	190	58,700	2,771	54.4	654	4.1	21.2	51.0	1,170	94.0	23.6
Average	240,000	202,000	.....	57	189	52,000	2,950	....	625	4.1	17.8	....	1,015	82.1	21.4

factors should be 20 to 25 per cent lower than with superheated steam.

$$C = \frac{\text{Combustion Factor} \times \text{Heating Surface}}{\text{Grate Area}}$$

The value to be given this factor is determined by the quality of the fuel to be used. For this reason no averages have been struck, as there is no meaning in an average based on varying grades of fuel. The individual figures show that the roads using anthracite aim at having a value of about 35 to 40, while the soft coal roads aim at about 55 to 60, for superheater locomotives. In saturated steam locomotives the necessity for greater heating surface tends to increase these figures from 10 to 20 per cent.

Factor of Efficiency of Design

$$E = \frac{\text{Total Weight}}{\text{Heating Surface}}$$

This gives the pounds of total weight per square foot of heating surface. Strictly speaking, this factor is an inverse measure of the efficiency of design, for the larger the factor the greater the weight the designer has required to secure the heating surface which is the source of power.

Values taken from Table 1 show average values for modern superheater locomotives as given herewith.

	Factor E
4-6-2	76
4-8-2	80
2-8-2	75
2-10-2	78
2-8-0	82

For saturated steam locomotives the values will be increased by from 15 to 20 per cent.

Superheater Surface as a Percentage of Evaporative Heating Surface

The meaning and value of this factor require little explanation. It is evident from Table 1 that the average value for all types is very close to 23 per cent, and it will be seen in the other tables that the variation of the individual values from the average is considerably less than for the other factors. This is natural as the same amount of superheat is desired irrespective of the locomotive type. The uniformity is also partly due to the design of the superheaters being largely in the hands of a single concern.

Use of Factors in Design

The factors which have been discussed afford a complete basis for a preliminary estimate of the general dimensions of a locomotive to fulfill any given conditions of service. Take for example the following problem:

Required the general dimensions of a Pacific type locomotive, to have drivers 70 in. in diam., to burn bituminous coal, and to be capable of developing a running tractive effort of 17,750 lb. at the rim of the drivers, at a speed of 40 miles per hour.

This means that $\frac{17,750 \times 40}{375} = 2,000$ horse-power must be developed. Assuming that 1.7 sq. ft. of heating surface are required for each horse-power, we find that 3,400 sq. ft. are required for 2,000 horse-power. The remaining dimensions follow at once if the various factors are given the average values taken from Table 1, viz.:

$$A = \frac{\text{Wt. on drivers}}{\text{Rated Tract. Eff.}} = 4.3$$

$$BD = \frac{\text{Rated Tract. Eff.} \times \text{Dr. diam.}}{\text{Heating surface}} = 840$$

$$C = \frac{\text{Heating Surface}}{\text{Grate Area}} = 55$$

$$E = \frac{\text{Total Weight}}{\text{Heating Surface}} = 76$$

Superheater Surface = 23 per cent of Heating Surface.
The results obtained are:

Total Weight	258,000 lb.
Wt. on Drivers	176,000 lb.
Rated Tract. Eff.	40,800 lb.
Heating Surface	3,400 sq. ft.
Superheater Surface	780 sq. ft.
Grate Area	60 sq. ft.

A preliminary lay-out of the general dimensions in this way is of great use to the designer, or in consideration of new power. It is of course to be understood that the dimensions correspond to average values and can be modified to suit the details of design and service.

Other Factors

There has been a practice of using some other factors for the same purpose as those discussed above. An examination of them will show, however, that they merely duplicate the information given by the preceding factors and throw no additional light on the proportions or performance of the locomotive. Among these factors are the following:

Total Weight Divided by Tractive Effort.—This is not an important comparison to make, as the connection between total weight and tractive effort is only secondary. The tractive effort has a direct connection with the weight on drivers which provides adhesion, and again with the heating surface which furnishes the steam. The total weight has a direct connection with the heating surface, as it represents the expenditure necessary to obtain the steam production. The relation of tractive power to total weight is indirect, the factor connecting them depending first, on the heating surface provided for the tractive effort which is governed by the speed required, and second, on the total weight required to provide each unit of heating surface, which is governed by the methods of the designer. It, therefore, follows that a comparison based on the relation between total weight and tractive effort is meaningless unless we know the relation between tractive effort and heating surface, and also that between heating surface and total weight. These latter relations are measured respectively by the factors *B* and *E*, and if they are known we gain nothing by computing a factor to show the relation between total weight and tractive effort.

Weight on Drivers Divided by Heating Surface.—This again is a secondary relation which has no meaning unless we know the relation between weight on drivers and tractive effort (factor *A*) and the relation between tractive effort and heating surface (factor *B*). When these two relations are known our useful knowledge is not increased by finding the combined relation between the weight on drivers and the heating surface.

Cylinder Volume in Relation to Heating Surface.—The volume of steam used per revolution at a given cut-off is proportional to the volume of the cylinders. Consequently the relation of the cylinder volume to the heating surface may be taken as a measure of the relation of steam requirement to steam supply. So long as the boiler pressure is the same, the comparison will be similar to that obtained from the *BD* factor. The cylinder volume relation, however, takes no account of the boiler pressure, and consequently in the case of two similar locomotives one with 160 and the other with 200 lb. per sq. in. boiler pressure, it would show no difference in the relation of steam consumption to steam production. Actually, although the volume of steam used is the same for both, the weight of the steam is approximately 21 percent greater for the locomotive with 200 lb. per sq. in. boiler pressure. The *BD* factor brings the boiler pressure into account, and shows the effect of the greater steam consumption and greater power due to higher boiler pressure. Comparisons made on the basis of the *BD* factor are there-

fore more representative of actual conditions than those made on the basis of cylinder volume.

Table of Dimensions of Modern Locomotives

Tables 2 to 7 give for 97 modern superheater locomotives, particulars of the general dimensions and of factors based on these dimensions. The average values of the factors for modern locomotives which are given in Table 1 are drawn

divisions would be advantageous as it would eliminate the costs of terminal handling, such as changing engines, cleaning fires, coaling, turn table and roundhouse service, time consumed, etc. It was believed these charges could be divided by three.

Accordingly on February 24, heavy Pacific type engine No. 2926 equipped with a Duplex stoker attached to Erie train No. 3, consisting of one mail car, one express car, two coaches,

TABLE 6—MIKADO TYPE, 2-8-2

Road	Total weight Lb. Wt.	Adhesive weight Lb. Wa.	Cylinder diameter and stroke In. dxx	Driving wheel diameter In. D	Boiler pressure Lb. P	Rated tractive effort Lb. T	Evaporative heating surface Sq. ft. S	Grate area Sq. ft. R	Superheating surface Sq. ft. Sh	Adhesive wt. Rat. trac. eff. A	Rat. trac. eff. Evap. surf. B	Evap. heat surf. Grate area C	R. T. E. x D Evap. heat surf. BD	Total weight Evap. heat surf. E	Superheating surf. as per cent of evap. surf. Sh/S
P. & R.	329,300	246,600	24x32	61½	225	57,320	4,224	108.0	993	4.3	13.5	39.2	835	78.0	23.5
L. V.	325,200	232,000	27x30	63	190	57,000	4,150	100.0	980	4.2	13.7	41.5	865	78.5	23.6
A. T. & S. F.	322,900	240,300	27x32	63	190	59,800	4,626	66.8	1,086	4.0	12.9	69.5	815	70.0	23.5
E. P. & S. W.	321,000	242,000	29x30	63	176	39,900	4,230	70.3	1,030	4.0	14.1	60.2	890	76.0	24.4
*P. & L. N.	320,000	239,000	27x32	63	190	60,000	4,285	70.3	993	4.0	14.0	61.0	885	74.5	23.2
C. P. R.	320,000	235,000	25x32	63	200	54,150	3,665	70.3	845	4.2	15.3	52.3	960	87.5	23.0
C. B. R.	319,300	236,900	27x30	62	205	61,500	4,035	70.0	1,154	3.9	15.2	57.6	975	79.2	28.7
C. B. & Q.	315,000	239,200	28x32	64	180	60,000	4,465	78.0	1,005	4.0	13.4	57.4	860	70.5	22.4
P. R. R.	314,600	237,500	27x30	62	205	61,500	4,058	70.0	962	3.9	15.2	58.2	975	77.5	23.6
M. K. & T.	314,000	233,500	28x30	61	185	50,600	4,341	62.7	1,025	3.9	14.0	69.1	855	72.5	23.7
C. C. & O.	311,400	230,000	27x30	63	190	56,000	4,117	78.0	933	4.1	13.6	53.0	860	75.5	22.6
N. Y., N. H. & H.	309,500	241,000	26x32	63	200	58,400	3,864	59.2	870	4.1	15.1	65.4	950	80.0	22.5
G. N. R.	306,500	229,000	26x32	63	180	60,930	4,665	78.0	918	3.8	13.0	59.8	820	65.8	19.6
I. & N.	302,000	236,000	27x30	60	185	57,000	3,943	58.0	922	4.1	14.5	68.0	870	76.5	22.5
Va. Ry.	297,500	229,600	26x32	56	185	60,500	4,350	57.0	910	3.8	13.9	76.5	775	68.4	20.5
Montour	296,500	249,500	27x32	57	185	64,500	3,892	66.7	836	3.9	16.5	58.2	945	76.4	21.5
I. C. R.	290,800	226,800	27x30	57	175	51,630	4,106	70.4	887	4.4	12.5	58.5	790	71.5	21.6
*B. & O.	290,800	221,500	26x30	63	200	54,600	3,777	66.7	945	4.1	14.5	56.5	910	77.1	25.0
C. G. W.	285,900	221,500	27x30	63	187	55,000	3,759	67.7	798	4.0	14.6	55.5	920	76.1	21.2
U. P.	282,800	219,400	26x28	63	200	51,100	4,216	70.0	912	4.3	12.4	60.2	780	67.2	21.6
S. A. L.	282,000	207,500	27x30	63	170	50,200	3,537	63.2	759	4.1	14.2	56.2	880	80.0	21.4
B. & O.	281,900	222,100	26x32	64	190	54,600	3,970	70.0	882	4.1	13.8	57.0	880	71.0	22.2
S. P.	280,960	214,000	26x28	63	200	51,000	4,215	70.4	890	4.2	12.1	60.0	760	66.8	21.1
A. C. L.	280,700	223,200	27x30	63	200	59,000	3,306	73.4	742	3.8	17.8	52.5	1,120	85.0	22.4
C. B. & Q.	278,600	211,300	27x30	64	180	52,200	3,364	58.7	751	4.1	15.5	57.4	995	83.0	22.3
N. C. & St. L.	272,700	215,800	25x30	58	180	49,500	3,804	66.6	840	4.4	13.0	55.5	755	73.8	22.6
Mo. O. & G.	232,000	177,100	23x28	52	180	43,600	3,778	57.2	838	4.1	11.5	66.0	600	61.4	22.2
V. S. & P.	217,500	168,400	22x28	57	200	40,400	2,573	46.0	546	4.2	15.7	56.0	895	84.6	21.2
Average	292,000	226,000	.....	61½	190	56,900	3,980	.....	900	4.1	14.1	.....	870	75.0	22.8

*U. S. R. A. 2-8-2-B. †U. S. R. A. 2-8-2-A.

TABLE 7—SANTA FE TYPE, 2-10-2

D. R. G.	428,500	337,500	31x32	63	195	81,200	5,369	88.0	1,329	4.2	15.1	61.0	950	79.5	24.8
Erie	417,200	337,400	31x32	63	200	83,000	5,863	88.0	1,389	4.5	14.2	66.6	890	71.3	23.7
B. & O.	406,000	336,800	30x32	58	200	84,500	5,573	88.0	1,329	3.9	15.2	63.5	880	73.0	23.8
B. & L. E.	404,250	332,700	30x32	60	200	81,600	5,191	88.0	1,237	4.0	15.7	59.0	945	77.8	23.8
Erie	401,000	335,500	31x32	63	200	83,000	4,959	94.8	1,274	4.0	16.7	52.5	1,050	81.0	25.7
Wabash	395,000	314,000	29x32	64	195	69,700	5,370	80.2	1,129	4.5	13.0	67.0	830	73.5	21.0
R. I.	383,000	302,500	30x32	63	185	71,900	4,608	80.2	1,180	4.2	15.5	57.5	980	83.0	25.6
St. L., I. M. & S.	370,000	294,500	30x30	63	186	72,500	4,617	80.3	1,170	4.1	15.6	57.5	985	80.0	25.4
C. B. & Q.	370,000	293,000	30x32	60	175	71,500	5,349	88.0	1,232	4.1	13.3	61.0	800	69.0	23.0
N. Y. O. & W.	352,500	293,000	28x32	57	190	71,200	4,498	80.0	1,007	4.1	15.8	56.5	900	78.5	22.2
C. I. & L.	341,000	275,500	28x30	57	190	66,700	4,761	70.0	1,235	4.1	14.0	68.0	800	71.8	26.0
T. & P.	324,600	262,100	28x32	63	185	62,600	3,846	70.0	886	4.2	16.3	55.0	1,025	84.5	23.6
Average	382,000	310,000	.....	61	192	75,000	5,000	.....	1,200	4.2	15.0	.....	920	78.0	24.0

from these tables. The individual figures need no further comment, but are of interest, both as giving the actual sizes of the locomotives, and as showing the deviations of the individual values of the factors from the average values.

Stoker Fired Locomotive Makes Continuous Run Over Three Divisions

To demonstrate the fact that a trip for a locomotive need not necessarily be limited to one division of approximately 100 miles as has been generally the fixed practice on railroads for many years past, the Erie Railroad recently planned a test run by which one of its through New York-Chicago passenger trains would be hauled over three divisions, by one engine alone instead of using three engines for the three divisions as is the practice at the present time.

This test was based on the belief that the superior firing service of the modern mechanical stoker on heavy locomotives and long runs would render fire cleaning unnecessary at the end of each division. Continuous operation over the three

two Pullman cars and one dining car left Jersey City at 12.18 p. m., for a continuous trip over the New York, Delaware and Susquehanna divisions, a total distance of 332.3 miles. The train arrived at Hornell, the final terminal at 11.28 p. m. on time, having covered this distance without incident in 9 hours and 13 minutes.

On the return trip, February 25, the same engine left Hornell at 10.57 a. m., one hour and one minute late, with train No. 4 consisting of one mail car, one express car, two coaches, two Pullman cars and one dining car, arriving at Jersey City at 7.00 p. m. on time. There was no hand firing done nor was the rake used during the round trip of 664.6 miles.

The fire was clean on arrival at Jersey City terminal, the ash pan being reasonably free from ash and not in any way clogged; and insofar as the condition of the engine was concerned, it could have been placed on another train and returned to Susquehanna over two divisions, a distance of 192 miles. This trip demonstrated decisively the practicability of one engine covering three divisions, and this was only made possible by this Pacific type engine being mechanically fired.

Design of an Improved Locomotive Throttle Valve

New Type Developed on Buffalo, Rochester and Pittsburgh, Has Many Advantages for Large Power

BY W. J. KNOX

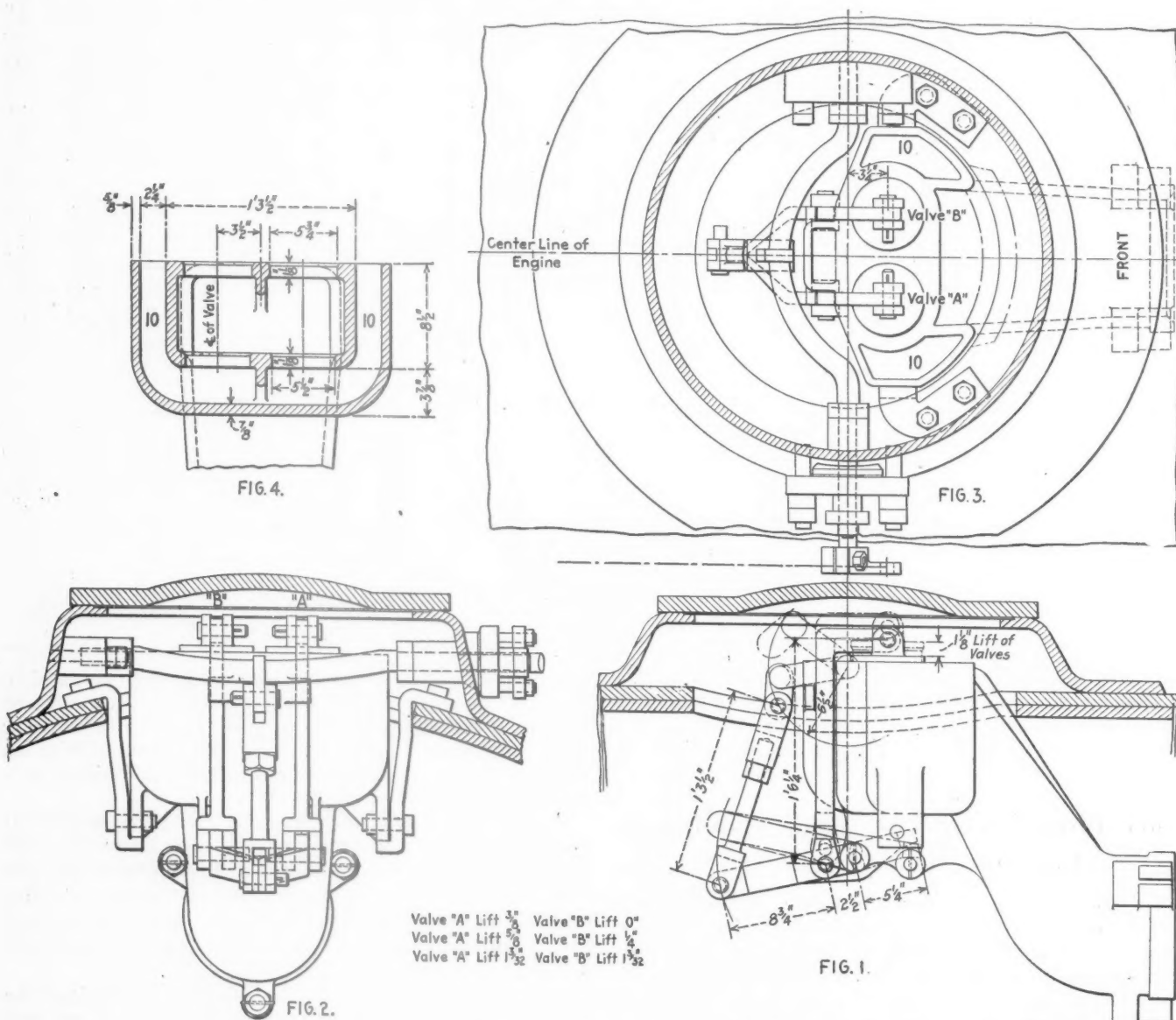
Mechanical Engineer, Buffalo, Rochester and Pittsburgh

THE mounting cost of labor and materials, the lack of money with which to provide terminal facilities and to increase rolling stock have all made insistent demands for more intensive operation and more refined and economical appliances and methods. Every department of the railroads has labored to better operation. The mechanical department, with the others, has made earnest efforts in this direction and while there have been very few radical or basic improve-

safety and security, all with the common desire to improve economy and increase capacity. One of the steps recently accomplished in this direction by the mechanical department of the Buffalo, Rochester & Pittsburgh is described in the following.

Problem of the Throttle Valve

For locomotives of maximum capacity to generate sufficient



General Arrangement of Throttle Valve

ments in the steam locomotive for some years, there has been a constant and steady rejuvenation and improvement of old and existing appliances and methods, and a constant development of new ones. Many of these aim at fuel saving through numberless channels, some at labor saving, others to promote

steam, the boiler must be extremely large. The limitations of clearances so restrict the height of the dome that the throttle standpipe is quite short and the distance above the water level, with three gages of water, to the steam admission level is small. To prevent priming it is essential, therefore, that

steam be admitted to the throttle on these large engines at as high a level as possible.

In American practice, the throttle valve is almost invariably a single valve of the poppet type, generally arranged for double admission with two seats or with single admission and a dash pot or piston to balance the single valve. In either case, especially when of the single admission form, to provide sufficient passageway without excess lift the valve must be very large in diameter and of great weight. If of the double admission type, it is difficult to so balance the valve that it can be operated without resorting to much compounding of the leverage and long travel of the throttle lever, or the pull required at the lever handle must be very great. Valves of the single admission type with balancing pistons, while more easily operated, have developed numerous faults in service.

The valves are cold when ground in and even though the work is well done and tested before steam is raised in the boiler, the large disc, when heated to the temperature of the steam at working pressure, becomes distorted and the valve cannot be kept tight. A further objection to the valve of large diameter is that when the engine is working light and a limited steam supply is admitted to the dry pipe, the large

service, and the trouble has been cured or at least greatly improved by using the design illustrated.

Operation of the Improved Valve

In the operation of the throttle valve the upward movement of the connecting rod, 1, from the position indicated in Fig. 5 first moves the valve member, 2, as shown in Fig. 7 and at the same time moves the lever, 3, to the position of Fig. 8, thus taking up the lost motion in the elongated pivot opening, 4, without causing any movement of the valve member, 5. A further upward movement of the connecting rod, 1, brings the parts to the positions indicated in Figs. 9 and 10, the valve member, 2, being opened still farther and the opening movement of the valve member, 5, starting. The lever, 3, is now moved so that its end, 6, engages the transverse rod, 7, this rod constituting the fulcrum for the lever during its further movement.

As the connecting rod is moved upward still further the valve members are opened simultaneously, the opening movement of the member 5 being more rapid due to the fact that the right hand end of the lever arm, 3, is longer than the corresponding end of the lever arm, 8. This movement of the lever arm, 3, is permitted by reason of the clearance in the

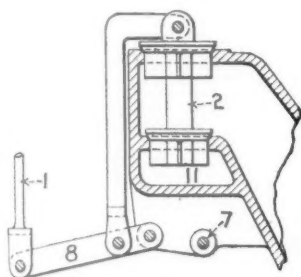


Fig. 5

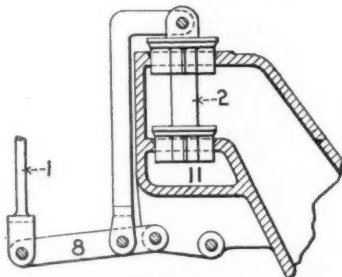
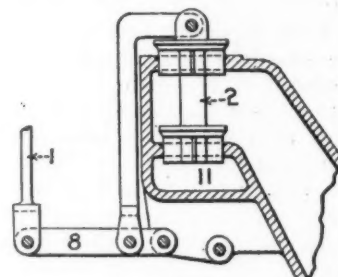
Fig. 7
Operation of Valve "A"

Fig. 9

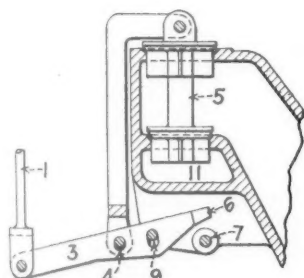


Fig. 6

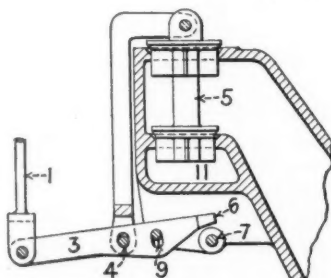
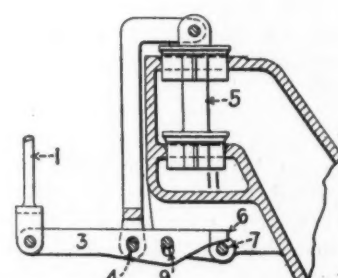
Fig. 8
Operation of Valve "B"
Details of the Operating Mechanism

Fig. 10

valve will be opened a mere crack. This results in wire drawing the steam between the joint face of the valve and seat, quickly cutting these joint faces and causing the valve to leak.

Leaking throttle valves have always been a source of trouble, annoyance and much waste of fuel, but with the introduction of the superheater other causes of fuel waste, shop expense and danger have been introduced, not before so apparent. When working with a throttle design permitting admission of steam at a low level much priming results and the superheater units must serve to evaporate the excess moisture, consequently reducing the resulting temperature and efficiency. From a leaking throttle and the results of evaporation in the units, courses of scale are built up in the header at the discharge ends of the units until the openings are almost or entirely closed. This prevents or retards circulation and the ends of the units next the fire become heated, are swelled spherically by the pressure and burst, a real source of danger and very expensive to repair. This is not a hypothetical case, but happens repeatedly after a few months'

elongated pivot opening, 9. At full travel both valves are open an equal amount. All the steam passing the throttle valve is admitted at the highest point possible, at the top level of the pipe. For the top seats the steam enters directly from the dome at the level of the seats. For admission through the bottom seats, steam is supplied by the ports, 10, to chamber, 11, below the valves as shown in the general arrangement, Figs. 3 and 4.

The opening provided by one valve before the second commences to lift is ample to pass the steam required by the locomotive when working light and can be graduated to meet the requirements when drifting much better than by so-called drifting throttles and special drifting appliances. The two valves are each one-half the diameter of a single valve and as they are arranged to open in sequence the lifting force required is only sufficient to overcome the unbalanced area of one small valve or is only one-half as much as for the large valve. The two small valves weigh less than the single large valve. The small valves are more easily machined, are much easier to grind in and experience has shown that they

are tight when first applied and remain tight in service. Frequent regrinding is not necessary.

Advantages of the New Design

Among other advantages claimed for this design of throttle valve is the fact that the waste from escaping steam is avoided and the danger from the locomotive moving, if not blocked, does not exist. Scale does not build up in the header, stop up the discharge openings from the units and prevent circulation. The danger from bursting and leaking superheater units is reduced to a minimum.

The heavy expense and lost time incident to taking out the units and welding or applying new return bends is thus avoided and the efficiency of the superheater is not impaired. Most important of all, the locomotive is not held out of service so frequently and is in safe condition to handle traffic economically.

A New Rod Design

In April, 1917, the Erie applied main and side rods of an unusual design as shown in the accompanying drawing to a ten-wheel locomotive which has since been operating out of Jersey City in heavy suburban passenger service. The change in design was accomplished by lengthening the main crank pin to accommodate the back connecting rod bushing outside of the main rod bushing. The crank pin on the rear driver was lengthened to correspond with the main pin and the cross section considerably increased to withstand the additional stress.

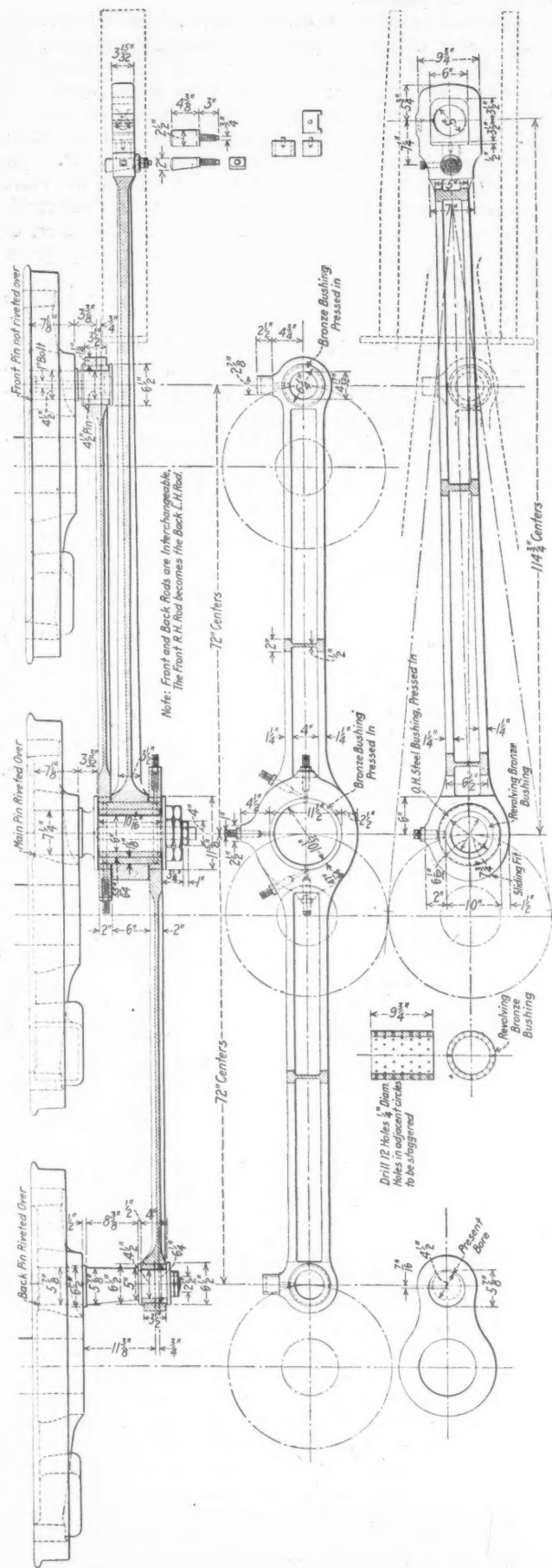
As will be observed in the drawing, this arrangement at once eliminates the customary clevis pin and bushing which serve to connect the forward and back side rods and renders each of these rods interchangeable on a locomotive of this type where the driving wheel centers are an equal distance apart and the bearings of the same dimensions.

The *Railway Mechanical Engineer* is indebted to William Schlafge, mechanical manager of the Erie, for the following information concerning this special design of main and side rods:

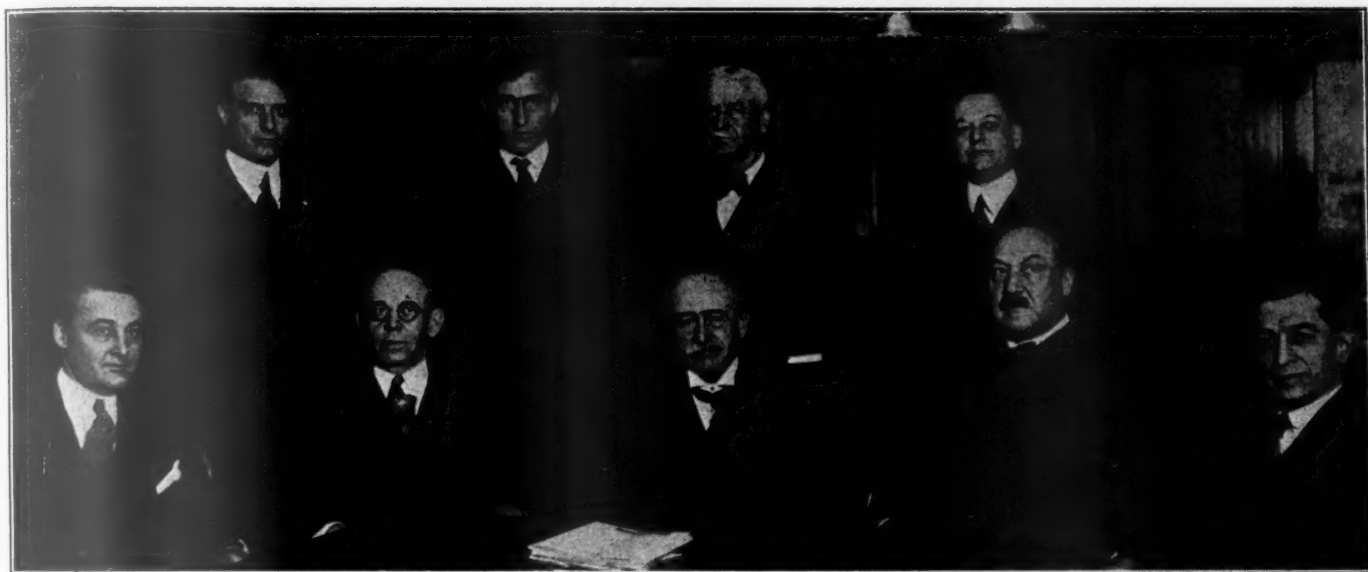
"By referring to the accompanying drawing illustrating the details and manner of application of these rods, the difference between them and the usual type of connecting rods applied to ten-wheel locomotives will be readily observed. These rods were applied to locomotive 916 in April, 1917. Since that date only one complete set of new bushings has been applied. This is an exceptional performance. Moreover, we have not had a case of a hot pin on this locomotive since these rods were applied."

The simplicity of the design together with the interchangeability of the forward and back rods is also a feature of importance on a ten-wheel locomotive and there appears to be no reason why the same design could not be applied in principle to other types of locomotives having a greater number of driving wheels. Under certain conditions, the simplicity of design taken into consideration with the excellent results being obtained in use on the Erie would seem to recommend the design to more general consideration.

KUNZE-KNORR AIR BRAKE.—The final trials of the Kunze-Knorr air brake, preceding their adoption on the railways of Sweden, were made on the Ange-Braecke Line, which has an almost continuous 1 per cent grade, 20 kilometers long. The special freight train used in the test weighed 1,300 tons, and had a length of nearly 700 meters, being made up of 57 cars with 132 axles. Traveling at 45 kilometers per hour, with 8 brake vans, the train was stopped within 70 sec. in 605 meters. At a speed of 20 kilometers per hour, the corresponding figures were 38 sec. and 145 meters. The brakes are reported to have given full satisfaction for regulating the speed of the train.



Arrangement of Main and Side Rods Which Eliminates Knuckle Pins and Split Brasses



Railroad Labor Board. Standing, left to right: A. Phillips, L. G. Brooks, H. Baker, G. W. Hanger. Seated, left to right: H. T. Hunt, J. J. Forrester, R. M. Barton, chairman; W. L. Park, A. O. Wharton.

Railway Executives Testify Before Labor Board

Labor Unions Present a "Bill of Rights"; Roads
Request Conferences to Discuss Wage Reductions

THE principal development in the hearings before the Labor Board during the past month was the summoning and cross-examination of several railway executives. B. M. Jewell, president of the Railway Employees Department of the American Federation of Labor, on March 5 asked the Labor Board to subpoena the members of the labor committee of the Association of Railway Executives, which was abolished, to appear as witnesses when he resumed his reply to the presentation made on behalf of the carriers in the national agreements controversy. The request was filed by Mr. Jewell as an answer to the action of the Association in abolishing the committee.

Several days previous Mr. Jewell filed a letter with the Board charging that the railway executives are in a state of dissension over the question of abrogating national working agreements. He urged that before proceeding further with the cases now pending the Board should rule on the request of the unions for a national conference with the railway managements over the agreements.

The letter charged that a year ago a majority of the railroad executives were in full accord with the union leaders on the question of establishing bipartisan boards of adjustment and declared that Gen. W. W. Atterbury as a "minority of one had ridden roughshod" over the other executives.

"He prepared a minority report," the letter states, "and presumably because of the support which he was able to secure from the financiers who dominate the transportation industry, was able to thwart the will of the other executives, prevent the establishment of the national boards of adjustment, and refuse any conferences on national agreements."

After a delay of two weeks, granted by the Board to Mr. Jewell to prepare his rebuttal statement to the presentation which had already been made on behalf of the carriers, Mr. Walsh and Mr. Jewell appeared before the board on March 14, stating in substance that "it will be impossible for us to proceed with the presentation of our case until the witnesses we have called for have been subpoenaed and have presented themselves for examination."

During the course of Mr. Walsh's opening remarks it developed that in reply to the employees' request for subpoenas, the Board, before taking action, had requested them to state what they expected to prove from the testimony of these witnesses. In reply to this Mr. Walsh stated that the employees expected to establish:

(1) What led to the carriers' decision to have National Agreements abrogated; (2) why the carriers have refused to meet representatives of the employees on this subject; (3) whether the executives are fundamentally interested in doing away with the waste and extravagance chargeable to the National Agreements; and (4), whether these executives really believe that National Agreements are unworkable, unjust and unreasonable.

In addressing the Board on March 14, Mr. Walsh said in part:

"My clients are in no sense responsible for the delays in these proceedings, nor will they remain silent under any such imputation. We have been ready from the outset to go forward in an orderly way to a speedy determination of the issues involved in this controversy, and we submit that the whole matter could have been disposed of weeks if not months ago, if we had been granted the conferences which we asked of the railroad executives, or if this board had taken steps to bring about such conferences.

"The delay has been both disturbing and costly to the general public. It has contributed largely to the uneasiness and uncertainty in all business and in all industry which have prevented that return to normal activity and productivity in which we are all so vitally concerned. It has recruited thousands upon thousands to the army of the unemployed. I, for one, am apprehensive of the economic and political consequences that may ensue when we have a horde of hungry men, women and children in this country."

On the insistent demand of Mr. Walsh and Mr. Jewell, Robert S. Binkerd, assistant to the chairman of the Association of Railway Executives; General W. W. Atterbury, vice-president of the Pennsylvania and chairman of the

association's disbanded labor committee; Carl R. Gray, president of the Union Pacific, and a member of the labor committee before its abolishment, and Thomas DeWitt Cuyler, chairman of the association, were summoned by the Railroad Labor Board to appear before it on March 18.

In addition, members of either the old labor committee or the Conference Committee of Managers of the Association, were notified to hold themselves in readiness for a similar call. Mr. Binkerd was requested to bring with him the minutes, letters, recommendations and other records having to do with the proceedings of the association and its labor committee with reference to the dispute now before the Board.

These developments were brought about by the adoption of resolutions by the Board on March 14 after Mr. Walsh and Mr. Jewell had maneuvered for additional delay and again declined to meet the issue, namely, the justness and reasonableness of the National Agreements now in effect.

B. M. Jewell Presents a "Bill of Rights"

When this part of the hearings opened on March 18, Mr. Jewell read a "bill of rights," outlining the basic principles upon which he said the National Agreements are founded and for which the employees' representatives are fighting. This statement outlined in general the plan of attack later followed by Mr. Walsh in his examination of the various witnesses.

After stating that representatives of the employees have repeatedly attempted to have this controversy remanded to joint conferences and that "an aggressive and misguided minority of railroad executives has seized upon the question of National Agreements as the means of misrepresentation of the railway employees before the public and as the occasion for an attack on labor organizations," Mr. Jewell said:

"The fundamentals which are the basis of the National Agreement are as follows:

Eight hours as the recognized measure of the standard work day with an adequate hourly wage.

Payment for time worked in excess of the regular eight hours at proper over-time rates for the various characters of service required.

The beginning and ending of working shifts to be so arranged as to permit of reasonable living arrangements by employees and their families.

Reasonable rules for the protection of health and safety of employees.

Clear and concise definition of the work of each craft to be performed by mechanics and helpers.

The formulation of apprenticeship rules so as to develop sufficient, competent and efficient mechanics.

Applicants for employment as mechanics to be required to show that they have served an apprenticeship of four years or performed mechanics' work for a similar period and they not to be denied employment, when their services are needed, for any reason other than their inability to perform the work for which they are making application for employment.

The right of majority in each craft to determine what organization shall represent them. This organization to have the right to make an agreement which shall apply to all workers in each craft.

The right of the majority of each craft on each railroad to select a committee or representatives who shall handle all grievances which may arise affecting all employees of the craft in accordance with the provisions of the agreement.

Craft, point seniority, limiting seniority to the local shops or points and not permitting interchange of seniority with other shops, crafts, or departments of railroads.

The right to organize and the protection of employees against discrimination because of membership in labor organizations or for any other reason.

"These fundamentals constitute the irreducible minimum in labor's bill of rights," he continued. "If machinery is to be successfully established for the peaceable settlement of the disputes between management and employees on the railroads these fundamental principles are an absolutely necessary preliminary."

As a result of the carriers' recognition of these principles, Mr. Jewell said that "well rounded and smooth running machinery would now be in operation and peace on railroads

and good-will between management and employees would prevail where now exist growing distrust, dissension, dissatisfaction, and increasing rumblings of a fast approaching, costly and vicious conflict, such as existed in the railroad industry prior to December 31, 1917.

"If it is proper, and we admit it is," he continued, "for railroad management of all railroads to have a national union of management, then, by the same line of reasoning, it must be admitted that the employees are entitled to the same. Railroad management is willingly accepting all the benefits of the Transportation Act, and just as willingly and determinedly is it endeavoring to escape its burdens. The law itself is not being given the fair test which it should be given.

"The facts are, there is at present and for years past there has been no individual and independent railroad management with which the employees could bargain collectively. Railroad managements' labor policy is practically dictated by and through a small committee. Railroad managements' policy thus dictated is then sought to be imposed upon a local railroad craft organization of employees by and through the national union of railroad management. Railroad labor's organizations and policy are formulated in order that it may hope to successfully cope with the compactly and nationally organized union of railroad managements."

Cross Examination of Railroad Executives

Following the presentation of this statement Mr. Walsh called Mr. Binkerd, Mr. Cuyler, Mr. Gray and General Atterbury to the stand.

By the testimony of these witnesses Mr. Walsh attempted to prove:

1—That national boards of adjustment and National Agreements are inseparable.

2—That railway executives are divided on the question of national boards of adjustment and therefore on National Agreements.

3—That Mr. Cuyler and General Atterbury, alleged representatives of capital, have exerted a powerful influence in opposition to National Agreements as part of a general attack upon labor organizations.

4—That the carriers are organized nationally to treat labor and other problems and they therefore should treat with the employees nationally.

5—That the basic principles of the National Agreements are just and reasonable even when applied nationally.

6—That the railroads are unfairly moulding public opinion to influence the Labor Board.

7—That the labor policy of the railroads is dictated by a handful of executives.

8—That the Association of Railway Executives and its officers wield more than an advisory power.

From Mr. Binkerd, Mr. Walsh elicited information regarding the history, purposes, organization and powers of the Association of Railway Executives and detailed information regarding the files of that organization which he presented in accord with the order of the Board. From Mr. Cuyler, Mr. Walsh obtained information regarding his position and influence in the Association and the extent to which publicity work has been carried and by whom. Mr. Gray proved a distinct disappointment to the labor leaders, for he outlined in unmistakable terms the opposition of the executives toward continuation of National Agreements, and met every attack on their position with opinion and evidence gained through many years of railroad experience in every part of the country. Mr. Walsh retired from the examination after a short time, leaving the interrogation of Mr. Gray to counsel for the carriers.

General Atterbury completed the wreck of the hypothetical case as visioned by Mr. Walsh. He was not only not content to take the defensive, but at times took a hand in the questioning and backed up his contentions with proof.

It had been confidently expected by the labor leaders that, through the testimony of Mr. Gray, it would be possible to establish the existence of a difference of opinion among railway executives as to the justness and reasonableness of Na-

tional Agreements, and thus materially weaken the carriers' case. However, the dispatch with which Mr. Gray killed this plan led Mr. Walsh, after a short time, to retire from the examination. Counsel for the railroads, however, asked Mr. Gray to present testimony as to the reasonableness or unreasonableness of National Agreements. To this Mr. Gray stated that the varied conditions existing in different parts of the country makes it practically impossible to devise rules which can be applied justly and reasonably over the whole country.

The "bill of rights," previously presented to the board by Mr. Jewell, was then brought to Mr. Gray's attention, and the manner in which these rules worked out in actual practice when applied universally, was quickly pointed out.

Cross Examination of General Atterbury

On March 21 General Atterbury took the witness stand, and, in response to questioning, outlined his connection with the Pennsylvania, the Association, its Labor Committee and other railroad organizations. This led Mr. Walsh to submit a long list of organizations of executives and subordinate officials, which, he maintained, treated railroad problems nationally, and inferred that questions in which the employees were interested should be treated on the same scale.

In answer to a question regarding the importance of the abrogation of National Agreements, General Atterbury said: "The abrogation of National Agreements is the most important thing before the country today."

During the progress of the examination, Mr. Walsh attempted to point out a difference in the positions taken by General Atterbury and Mr. Whiter's committee.

In reply to Mr. Walsh's request that he add something to Mr. Whiter's presentation, General Atterbury read a statement which said in part:

"No more serious question (National Agreements) confronts the American people today. We have come to a parting of the ways. One road leads to government ownership, nationalization, Plumb Plan-ism, and Syndicalism,—the other road, to industrial peace, and the continuation of that individual initiative, energy and responsibility which is peculiarly American. The issue is in your hands. The signboard on one road is: National Agreements. The signboard on the other is: Negotiate directly with your own employees.

"The following quotations from the Official Circular No. 107 of the Railway Employees Department of the American Federation of Labor, which circular as an interesting coincidence, is headed 'Yours for Government Ownership of Railroads'—are illuminating.

We are the first class of railway employees to force the understanding that the Railway Administration would negotiate and sign a National Agreement.

It was up to him, the Director General, to settle with us and further the entire proposition would be submitted to our membership at once for a strike vote.

"The other road I have indicated leads to industrial peace. I can quote no better testimony advocating following the signboard—'Negotiate with your own employees' than the following, taken from the Report of Industrial Conference called by the President, of which William B. Wilson, Secretary of Labor, was chairman, and Herbert Hoover, vice-chairman.

The right relationship between employer and employee can be best promoted by the deliberate organization of that relationship. That organization should begin with the plant itself.

Industrial problems vary not only with each industry, but in each establishment. Therefore, the strategic place to begin battle with misunderstanding is within the industrial plant itself. Primarily the settlement must come from the bottom, not from the top.

"My views as to what the employees should not do, are as follows: (1) undermine discipline; (2) limit production; (3) demand pay for which there is no equivalent production; and (4) force the 'closed union shop.'

"I have no fight with organized labor as such. I have every desire to see its existence healthy and normal. Within reasonable limits, it is a healthy spur to bring about fair conditions as between employer and employee.

"My views as to what the employee has the right to expect and the employer should provide, are as follows: (1) as steady employment as possible; (2) a good wage; (3) time for recreation; (4) opportunity to elevate himself in his employment; (5) a voice in determining the rules and regulations under which he should work; and (6) the right to be, or not to be, a union man. But to apply these principles, the 'dog collar' of National Agreements must be removed.

"An agreement to be properly binding must be equitable, and entered into freely by both parties; and in order that it may be intelligible and properly carried out, it is necessary that there be a common understanding. But a common understanding can only come from free discussion and negotiation.

"The so-called National Agreements were put in force on the Pennsylvania by order of the Director General. No discussion whatever was held between the employees who would work under these agreements, and the officers who necessarily would have to administer them. Nor have the employees who work under these agreements been permitted by their leaders to discuss them with their own railroad officers, or modify them as a result of such discussion."

After calling attention to the hurried effort on the part of the leaders of the shop crafts to make the question of National Agreements an issue before the Board, General Atterbury continued:

"Confusion, misunderstanding and bitterness between the officers and the employees were bound to, and did follow, and are bound to continue until the so-called National Agreements are wiped out, and the officers and employees now working under them on the Pennsylvania sit down together and work out their own set of working rules to meet their own conditions. You may fairly ask what justification I may have for this statement I have just made. Your Board some time ago very wisely decided that it had no jurisdiction over the question of national boards of adjustment. That decision took that 'dog collar' off. What followed on the Pennsylvania with our men in train and engine service is typical and convinces me of the possibilities in this direction with all classes of employees. There are no cases before the Labor Board from our men in train and engine service involving grievances as a result of the train and engine service rules and working conditions on the Pennsylvania. Our men and our officers are settling them between themselves. Understand that there were in existence seven separate schedules, covering different parts of the system and you must recognize that we have varying conditions incident to serving a territory with agricultural, industrial, and climatic differences, that stretches from the straits of Mackinaw to the Chesapeake Bay, and from the Atlantic Ocean to the Mississippi river and the waters of Lake Michigan.

"Each railroad negotiating its schedules with its own employees is the road to industrial peace."

There followed an interesting controversy between General Atterbury and Mr. Walsh as to the formation of the various National Agreements. General Atterbury vigorously maintained that these agreements were obtained from the Director General by coercion and stated, in support of this contention, that Director General Hines "took strike threats too seriously; his experience in handling labor matters had been too limited."

The next move in the examination was openly announced by Mr. Walsh when he said: "I will now try to prove that some universal rules are necessary." Following this he introduced considerable evidence regarding the legislation designed to safeguard railroad workers, various uniform rules promulgated by the Interstate Commerce Commission, etc. He then took up the rules contained in the National Agreements, and immediately found that, instead of examining the witness and directing the trend of the testimony, he was in turn being examined, and that the trend of testimony was being directed by General Atterbury. The first rule of the Shop Crafts Agreement was presented for General Atterbury's approval. It brought forth the reply:

"The eight-hour day is a perfect farce. It is merely a means for getting more money. The rule typifies the whole business. Why doesn't the rule say 'eight hours' work shall constitute a day,' instead of 'eight hours shall constitute a day's work.'"

General Atterbury then continued to bring out defects in the universal application of rules, stating again and again in discussing the applicability of the eight-hour day to railroad service that "the length of the working day should be gaged by the character of the service rendered." The remainder of the morning session was devoted to efforts on the part of Mr. Walsh and Mr. Wharton of the board to get General Atterbury to commit himself against the basic eight-hour day, but these efforts were without avail. In discussing other rules of National Agreements, General Atterbury took and consistently maintained the position that "no rule is a good

rule unless it is agreed to by the officers who apply it and men who work under it."

Inadvertently, perhaps, Mr. Walsh then mentioned the relative merits of piecework as compared with the hourly wage system. This led to vigorous defence of piecework by General Atterbury, who said: "The abolition of piecework has been made a bone of contention by men who would level all good Americans."

General Atterbury said: "I would negotiate agreements with our men right now if their leaders would let go." To this Mr. Walsh replied that he, General Atterbury, could legally negotiate agreements with his own men at the present time. The latter was evidently waiting for this opportunity, for he immediately produced two communications from the Railway Employees' Department of the American Federation of Labor to members of the shop crafts, telling them, in substance, not to negotiate any agreements except the complete National Agreement. Furthermore, General Atterbury took this opportunity to substantiate his term for the National Agreement—"dog collars." This expression, he said, originated in a cartoon contained in a bulletin issued by the Railway Employees' Department of the American Federation of Labor, portraying labor handing railroad management a small dog collar labeled "National Agreement." Railroad management is saying, "It won't fit." Labor is replying, "We'll make it fit." How the "dog collar" was made to fit was explained by General Atterbury by reading portions of the communication below the cartoon.

The result was both serious and amusing. Mr. Walsh, aided by Mr. Wharton, attempted to draw different conclusions from labor's statement, "We'll make it fit," but their attempts were not successful, and the course of the examination was quietly but quickly changed; however, not before General Atterbury had vigorously stated, "The leaders of the American Federation of Labor are throttling the employees and the National Agreements are throttling both the employees and the management. I don't want to take anything from the employee. I want only a fair day's work for a fair day's pay." In answer to a question by Mr. H. T. Hunt, a public member of the board, Mr. Atterbury said: "You cut the 'dog collar' off and see how quickly the Pennsylvania will negotiate agreements with its men."

On continuing this line of examination, General Atterbury exclaimed that the "whole object of National Agreements is to employ more men." Objections to this statement elicited the reply: "I am a better friend of the men than their own representatives at this table. I maintain, in fact, that the men are not being represented."

The remainder of the day's testimony was of a similar character, Mr. Walsh endeavoring to obtain General Atterbury's approval of the principles of various rules of the Shop Crafts Agreement, and General Atterbury consistently maintaining his position as has already been outlined.

The morning session on March 22 found General Atterbury still on the stand with the cross examination proceeding without results for the employees' case. The necessity for classification rules was first brought up by Mr. Walsh only to be denied in substance. Regarding this, General Atterbury testified: "I take it that this Board is to quiet not foment trouble. If it were to write standard rules instead of pouring oil on the waters it would be throwing rocks into it. The Board can't write standard rules."

Mr. Walsh stated that there have been but 175 disputes in a year under the National Agreements, and upon asking General Atterbury if that would not indicate harmony under these rules, the latter replied: "No. The boards at Washington have already given the men everything they have asked for. There is nothing more to request."

The apprentice rules in the Shop Crafts Agreement were next taken up, Mr. Walsh attempting to justify their existence by reference to so-called "abuses" which took place prior to their creation. This discussion ended when General Atter-

bury said: "I can find restricted production under every rule of the National Agreement, and this rule is no exception. You men are trying to get more money for the men; I am trying to get an honest day's work for that pay."

Regarding the representation of employees, General Atterbury maintained through a long series of questions that the principle of representation by men elected by the majority is not fair to the minority who have a right to be represented by men of their own choosing. Following this, General Atterbury outlined his definition of and views upon the "closed shop," stating in substance that he deprecates the closed non-union shop as well as the closed union shop. Furthermore, he read a circular issued by the Railway Employees' Department of the American Federation of Labor showing that that department has issued orders which establish closed shops.

The testimony during the afternoon session of the same day continued the same. Various of the rules were brought up by Mr. Walsh, and General Atterbury as strenuously objected to their application nationally.

Mr. Walsh attempted to capitalize the evidence that the Pennsylvania had maintained prior to General Atterbury's departure for France "an extensive espionage system among its employees" and had "little arsenals" at various plants. After lengthy discussion of the charges of coercion on the part of both the Pennsylvania and the employees, the subject finally dropped upon a promise by Mr. Hunt to read General Atterbury's complete report from which the charges were taken. Just prior to the closing of the morning session, Mr. Walsh produced a letter alleged to have been written by I. W. Geer, general manager of the Pennsylvania, southwestern region, to supervisory employees, in which he charged the supervisory employees to defame the labor organizations if necessary to obtain certain information. This letter was later declared to be a fake by General Atterbury and Mr. Whiter after they had communicated with Mr. Geer.

Mr. Walsh later turned to apparent discrepancies in statements as to the cost of the National Agreements. General Atterbury immediately produced a statement which Mr. Walsh tried to keep from the record. This statement, which was filed with the Board, showed by figures of the Interstate Commerce Commission that the estimated saving of \$300,000,000 was far below the actual saving possible.

A long series of questions regarding Master Car Builders' rules, etc., and their necessity followed, but throughout the session General Atterbury maintained consistently the stand which he had already taken on this subject. This completed the examination of witnesses summoned so far, and the Board adjourned until March 24, when Mr. Jewell began presentation of a long statement in reply to General Atterbury's stand before the Board.

Developments so far have not indicated when or how the labor leaders will attempt to answer Mr. Whiter's presentation, but from their present tactics it is assumed that this will not be presented until the Board has decided that the case has been delayed long enough.

Developments in Other Hearings

On March 1 representatives of the Brotherhood of Railway and Steamship Clerks, Freight Handlers, Express and Station Employees appeared before the Board to justify the agreements made with the clerks and present their rebuttal statements. Statements were also made by representatives of the signalmen and the Brotherhood of Maintenance of Way Employees and Railway Shop Laborers.

Wage Reductions Proposed on Many Roads

During the past month many roads have held conferences with their employees to discuss decreases in the wage scale. In a great majority of cases the men are not disposed to accept any reductions without action by the Labor Board. While the earlier conferences were confined principally to unskilled laborers, later developments include proposals to reduce wages of all classes of officers and employees.



The Safety of Passengers in Steel Railway Cars*

A Discussion of the Action of Cars in Accidents
and Methods Which Will Avoid Telescoping

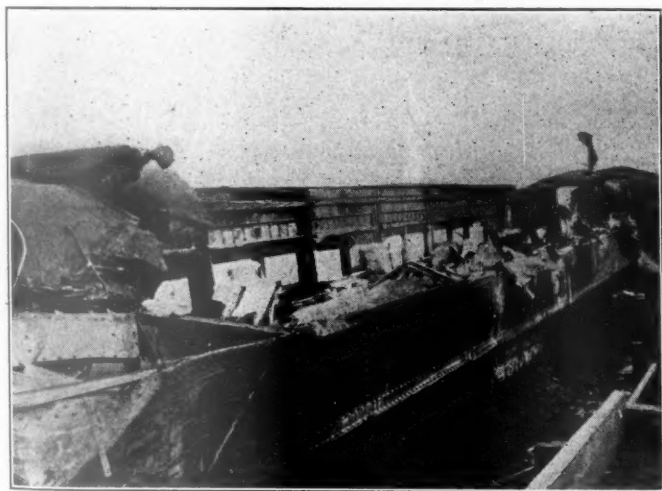
BY FRANK M. BRINCKERHOFF

THE general adoption of steel in place of wood in the construction of passenger train cars some 15 years ago marked a distinct advance in the art of car building. Various problems arose during the change, and many have been successfully met. The two most important problems

cars, though that aspect is, of course, very important.

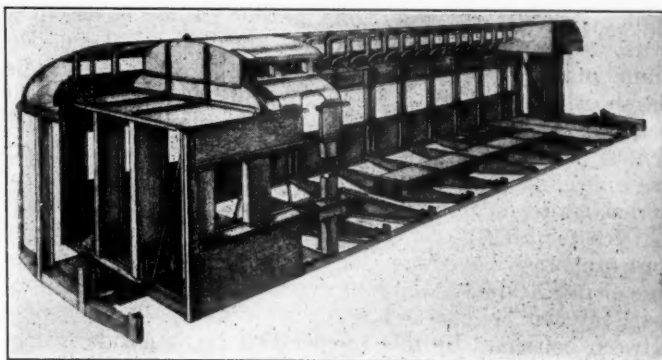
With regard to the problem of safety of passengers, I wish to present in a condensed form the results of an extended investigation of the behavior of passenger train cars when derailed or in collision, and to point out that, while the steel structure affords much greater safety to passengers than did wooden car bodies, modifications can be made in the superstructures of steel cars which will greatly increase their ability to resist destructive shock.

The data and some of the illustrations from which this paper is compiled can be found in the printed reports of accidents investigated by the Bureau of Safety, Interstate Commerce Commission, which are available to all; other illustrations are from photographs taken by various pictorial news



Wreck of a Derailed Chair Car Which Side Wiped a Standing Locomotive

To successfully defend the passenger space against invasion in side wiping collisions and derailments, strong sideposts must extend from side sill to roof and all the side frame members must be co-ordinated to ward off the colliding body.



Framework of Passenger Car

Showing collision diaphragm and bulkhead with high-girder side walls.

to be solved were and still are: safety of passengers and weight of complete car.

That some steel passenger cars are heavier than the wooden ones which they displace in service, seems to be indicated by the significant fact that the adoption of steel passenger train cars was frequently accompanied or closely followed by the purchase of heavier locomotives to handle the new passenger equipment.

It is not the intention at this time to discuss the economic consequences of the increased weight of steel passenger train

bureaus and have appeared in the daily press, and a few are from our office files.

In making our collection many hundred prints were examined and only those were selected which are of interest to car designers. It is greatly to be regretted that frequently the only available photographs of a wreck were taken as general views of the accident. Many valuable photographic studies of structural failures could have been made by an expert on the spot.

It was natural that the early designs of steel car structures should follow conventional lines and that the evolution from

*From a paper presented before the New York Railroad Club, March 18, 1921.

the all-wood car to the all-steel car should be gradual. It is now possible, however, to examine the photographic records of typical accidents to passenger trains and profit by past experience when designing and building new equipment.

For the purpose of analysis the illustrations have been divided into two groups: derailments and collisions. The records of the Bureau of Safety show that by far the greater number of accidents are in the derailment class though the loss of life and injury to passengers and equipment is greatest in the collisions.

Deraillments

Examining first the large derailment class it is found that a considerable portion of the momentum of the train is gradually expended in plowing up the roadbed and in tossing about the car bodies. Therefore, the violence of impact between the individual derailed cars is not comparable to the shock experienced in a rear end collision between a moving and a standing train wherein the momentum of the combined units of the moving mass, led by the locomotive, is concentrated in an impact upon the rear units of the standing train. This reduction in the degree of violence of impact is, however, somewhat offset by the fact that when cars are derailed the heavy underframe of one car is frequently projected against the relatively weak superstructure of an adjoining car with more or less disastrous results. Furthermore in derailments the cars are sometimes overturned or fall upon a neighboring car; in such cases the superstructure of the car is subjected to extremely severe stresses.

Examination of many illustrations of accidents of the derailment and side wiping class, led us to the conclusion that distribution of metal which would strengthen the superstructure of the car as compared to the strength of the underframe was highly desirable. During the last 10 years or more, 315 cars have been built according to a system evolved, with the purpose constantly in mind, to produce a car body structure of great strength, but still of a weight not in excess of wooden car bodies of similar size and equipment. I wish to introduce at this point a short description of this system which affords unusual protection to the passenger space when cars are derailed or side wiped.

A Car Body Structure of Greater Strength

The sideframe members of these cars are organized in the form of a girder extending from the side sill to the side plate at the roof line, a height of 7 ft. 6 in. or more. The underframe of this system includes centersills adequate to sustain the shocks of collision, draft, etc., but instead of being of the fish belly type, designed to be self-supporting between truck centers, as is the usual custom, the centersills of this system are uniform in section throughout their length and are supported approximately every six feet by heavy cross bearers between the high girder side frames. The centersills, being thus supported, have no measurable deflection and are, therefore, superior in capacity to resist end shock to those of much greater weight and depth which are self-supporting between bolsters. By this co-operation between side frames and centersills a great reduction in weight per car is accomplished and yet a much stronger body structure results.

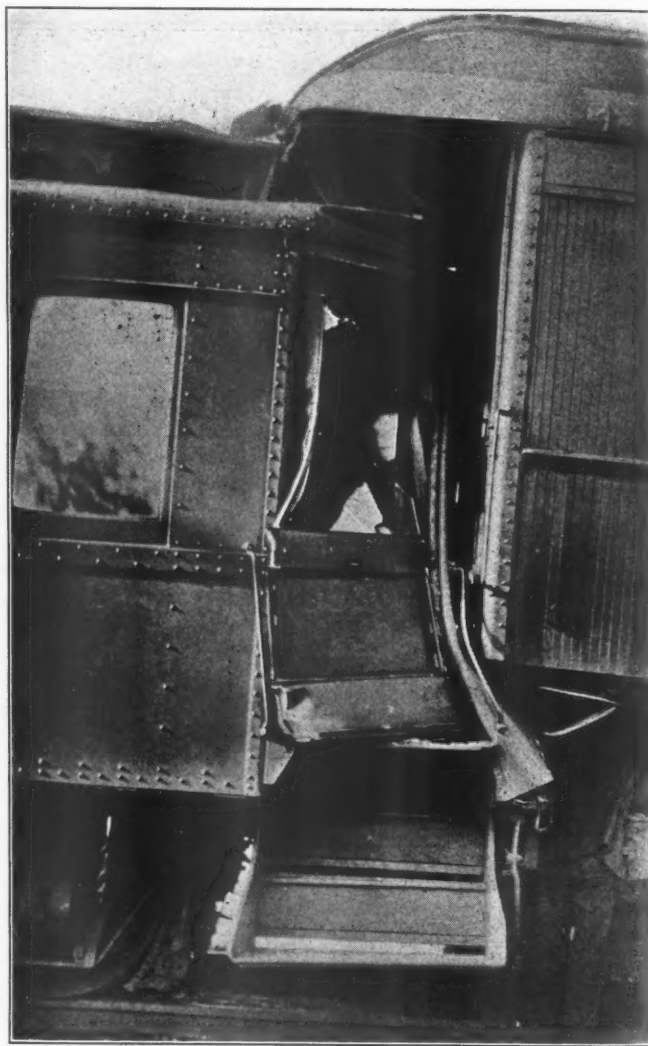
The ends of the bodies of these cars are reinforced against the stresses of impact to an extent considered appropriate to the service in which the cars are employed, some of these cars being electrically operated in tunnel service, others in suburban steam and suburban electric service, others in through line steam service at high speeds and in heavy trains. The system of end reinforcement is, of course, carried to the greatest extent in the cars in the latter service where the greatest momentum is to be dealt with in case of accident.

This system of reinforcement of the ends of the car body co-ordinates the body end walls with the members of the high girder side frame and roof in the form of a rectangular

tube with ends barred to prevent penetration by an impacting body. This is accomplished in the through line cars by the introduction of two new members:

1. An anti-telescoping tie plate extending across the car from side plate to side plate and lengthwise of the car for about six feet forming a flat ceiling for the lavatory, passageway and saloon and being securely riveted to the plate of the high girder side frame.

2. Special deep piers forming the posts for the door in the end of the car body. These piers are approximately 21 in. deep and as in some classes of accident they may be subjected to tension. The web plates of these piers pass through the upper tie plate and also through to the underframe and are, together with their flanges, securely riveted to each of these members. The corner posts and the adjacent side posts of the



First Stage of Telescoping of Steel Cars

The body of the chair car has overridden the buffer sill of the coach.

car body are also specially designed to withstand the shock of cornering collision.

The car structure thus formed is illustrated in the perspective drawing shown, from examination of which it will be seen that the compression member of the high girder side frame effectively braces this reinforced body end at the roof line.

The extent to which the high girder side frame and body end reinforcement of passenger car bodies will protect the passenger space when in collision or derailment can be somewhat gaged by examination of the damage to steel baggage cars after being involved in accidents of these classes. Baggage cars, because of the typical arrangement of their side

doors, windows, etc., have in effect high side frames, with the elements of plate girders, extending from side sills to roof line at the car body ends. The high girder side frame and body end reinforcement of passenger cars, above described, co-ordinates all the strength elements of the car structure even more effectively than does the form of plate girder side walls of the usual baggage car, and in addition the body of the passenger car will be protected to a certain degree by the wreckage of its vestibule which, when in collision, will be forced back against the reinforced body end. Comparatively little damage results to baggage cars with high side walls when colliding with coaches of the usual low frame con-



End View of Coach Shown in Previous Illustration

The chair car has commenced to exert a bursting stress upon the body of the coach.

struction, thus demonstrating the advantage of the high structure when subjected to end shock.

Rear Collisions

Considering next the illustrations of typical rear collisions, it is interesting to note that, where cars with steel underframes are involved, the penetration by the locomotive into the rear car seldom exceeds the depth of the vestibule and that the greatest damage occurs where one car overrides another. The pilot of the locomotive usually underruns the rear car until the buffer sills of the car come in contact with the heavy frame of the locomotive, where further progress is arrested and the penetration of the vestibule structure by the locomotive boiler or smoke box ceases.

When one car overrides another the penetration is in some instances complete, the entire length of the invaded car being practically destroyed. Careful analysis of typical photographic records of railway wrecks will lead to the following conclusions:

1. The underframe of the modern steel passenger car is adequate to withstand the shock of the most violent collision.
2. The underframe of the invading car overrides the underframe of the invaded car and wedges its side walls apart, the point of impact being a foot or more above the floor according to the upward angle assumed by the overriding underframe.
3. The superstructures of steel cars fail to protect the passenger space, when overridden in collision by a car having a steel underframe, because of the relative weakness of the

invaded superstructure as compared with the heavy underframe of the invading body.

4. The joints connecting the side walls, hood and roof are subjected to tension because the invading body having penetrated between the side walls, exerts a bursting stress on the invaded structure. The members composing the roof are always light in section and the joints connecting them to the sides inadequate to resist the heavy tension stress of collision.

5. The structure of the invading car is subjected to compression, and as the joints connecting its members are better able to resist compression, than the invaded car structure is to resist tension, the invading car body is seldom seriously damaged.

Accurate computation of the force expended in a collision between trains is practically impossible. Two reactions, however, occur in all rear end collisions, which can be used to roughly gage the violence of the shock, namely:

1. Depth of penetration by the invading car, and
2. The distance the standing train is driven ahead by the force of the collision.

These reactions are complements of each other and roughly indicate the energy expended.

With these reactions in mind it seems highly desirable that the invading car be restrained from penetration by some device which will cushion the impact shock and impart motion to the standing train, thus diverting the force from the work of destruction to the work of moving the mass.

It is obvious that in a train collision the points of impact



The Second Stage of Telescoping

When telescoping has reached this stage the structure can offer but little resistance to further penetration by the invading body.

will be more or less damaged. It is impossible to build a car structure that will successfully resist all damage by an overriding car. The problem is to provide means to arrest the progress of an invading car before it penetrates deep into the invaded structure, meantime transmitting the force of the collision to the standing train to set it in motion.

The essence of this problem is the element of *time*. The structure best adapted to solve the problem must contain members which will act to resist penetration at the vestibule end and interpose a rapidly increasing resistance to the progress of the invading car.

The essential characteristics of a member best suited to

accomplish the above ends are: *Flexibility* to avoid shearing; *elasticity* to avoid abrupt stressing; *high ultimate strength* in tension to resist bursting stress exerted by an invading car.

Use of Wire Cable Proposed as Remedy

Manifestly the material best adapted to meet the above requirements is *wire cable*. The manner of introducing the wire cable in a car structure may vary considerably. One form may be described as follows:

A wire cable anchored to the underframe of the car, passing through the vestibule buffer sill, up through the vestibule corner post, across the hood, down the opposite corner post, through the buffer sill to the anchorage point at the underframe.

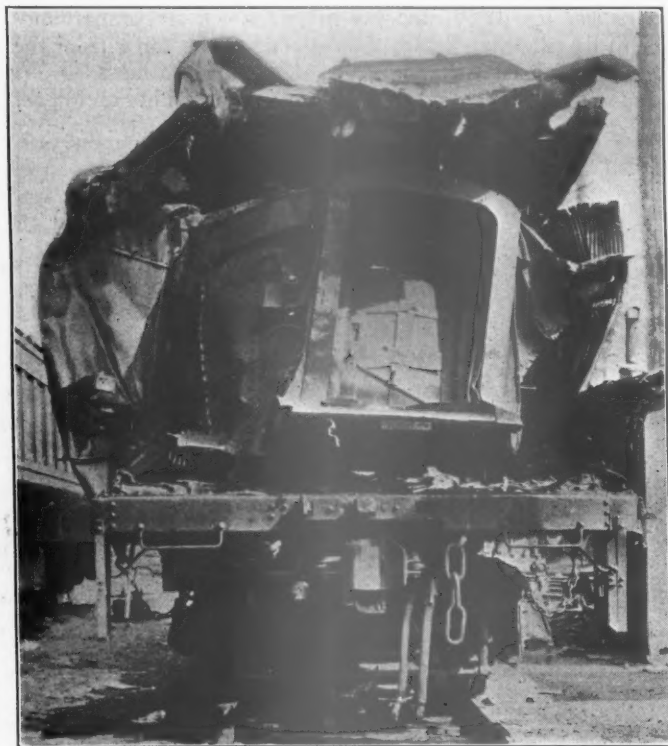
The loop is thus distended in such a manner that the vestibule end of an invading car will penetrate within the loop. The initial shock of collision will be met as now by the vestibule end posts. When the resistance of these end posts is overcome and as the invading body progresses, the cable loop, together with the members of the invaded vestibule will be drawn in and down against the vestibule of the invading body crushing both within the confines of the loop.

The more resistant the structures thus crushed, the greater will be the energy absorbed and the greater will be the pull

The size and number of the cables and the number of groups or lines of defence can be increased until all reasonable doubt of their collective ability to arrest an invading car disappears.

In the absence of the wire cables, a corresponding collision would result in wedging apart the invaded structure with comparatively little dissipation of energy and imparting but little motion to the standing cars, because the energy expended in wedging aside the members of the structure is exerted at almost right angles to the direction of the invading body and consequently, results in but little forward thrust.

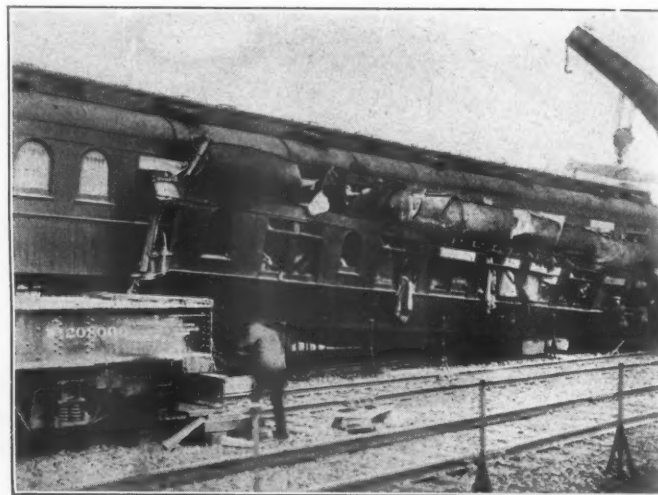
The arrangement of the cables is purposely such that it is impossible to bring an abrupt stress on them. They are dis-



End View of the Car Shown in the Last Illustration

exerted by the cable, through its anchorage in the underframe, to impart motion to the mass.

The design further provides for a second group of cables, imbedded in the body corner posts and body end frame, to act as a second line of defence against the invading car. Should the force of the collision be not completely dissipated through the resistance of the vestibule end posts and the cable in the vestibule end, the invading car body will next encounter the high resistance of the body end wall, and the second group of cables will come into action upon being encountered by the invader. The second group of cables being also anchored to the underframe and distended in loop form will also draw the structure of the invaded car down and in upon the invader and similarly impart motion to the mass. This second group of cables will also act to draw downward and inward the roof and sides of the invader.



The Final Stage of Telescoping

The complete separation of the side walls of the invaded car indicates the desirability of incorporating strong tension members in the superstructure.

tended in an approximately rectangular loop by members which, when subjected to collision shock, are bent and distorted by the cable which is of superior strength to any member with which it is associated except only the centersill to which it is anchored. For example the combined tensile strength of the cable loops shown in the illustration is 2,000,000 lb., and therefore equivalent to the ultimate strength of centersills having a cross section of approximately 50 sq. in. Consequently when a car body protected by cables is invaded, the vestibule of the invader will be crushed down and the zone of destruction in the invaded car will be limited to the area enclosed by the cable loops engaged.

Length of Path of Resistance

Thrust will be imparted to the centersills of the car in which the cables are incorporated, from the moment of impact upon the vestibule end and in a gradually increasing degree until all the cable loops are drawn in and down to a position of rest against the crumpled structure of the invading car. This prolonged and steep path of resistance is of the utmost importance.

In the illustration the cable loops are shown in combination with a high girder side frame and body end reinforcement as first described. This we consider the strongest form of car body construction in use today. When completely equipped with cable loops, this design provides the following path of resistance to penetration by an invading body:

1. A rigid vestibule end wall having as high initial resistance as practicable.
2. Cable loop, enclosing the vestibule end wall and acting to retain the structural members in the path of the invading body, upon the failure of the initial resistance of the vestibule end wall.

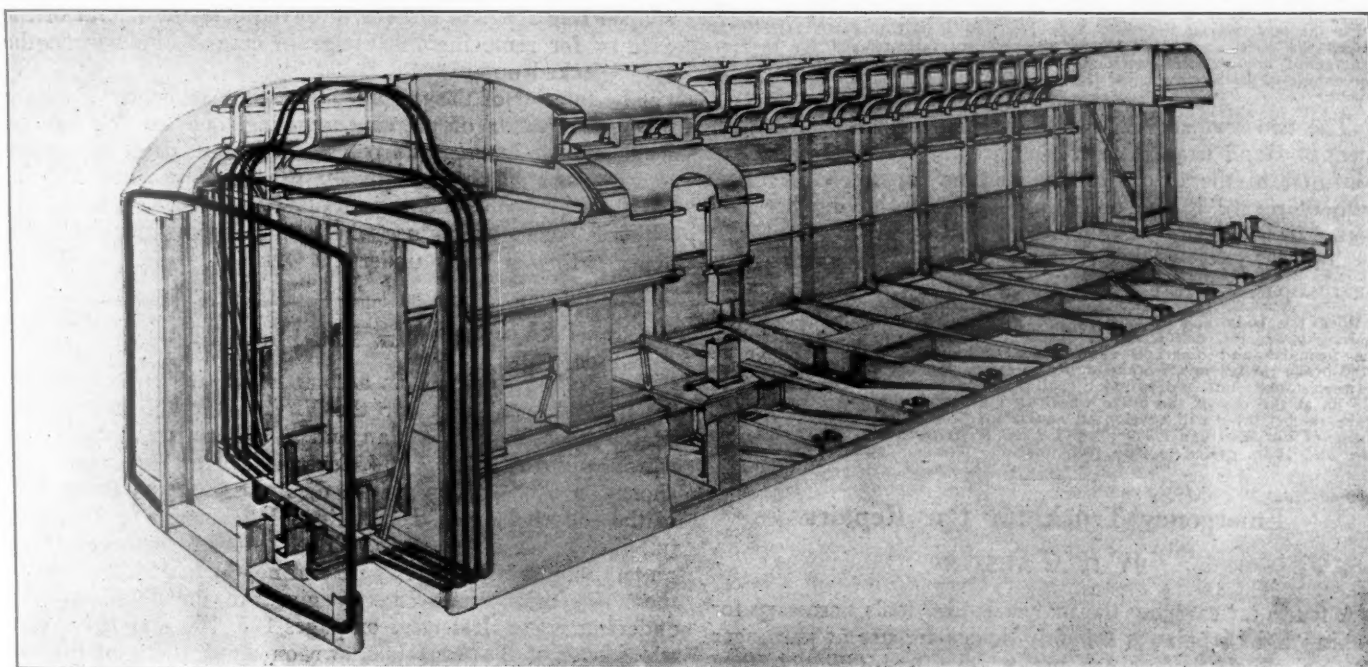
3. A rigid body end wall including the strong piers at the doorway and the deep body end reinforcing plate, collectively over five times the section of the vestibule end.

4. The second group of cables which will act to prevent disruption of the body end wall structure and any further penetration.

The resistance effected by the cable loops is accumulative and the ultimate resistance will not be reached until the wreckage of both vestibules is compressed in a tangled mass within the confines of the loops engaged. The crumpling of the structural members within the cable loops will act to cushion the shock. The resistance will increase rapidly in a series of steps beginning with the resistance afforded by the rigid vestibule end posts and reaching a peak equal to the accumulated resistance of the four stages in the path of resistance above described. The body end structure being of much greater strength than the vestibule end structure will insure that the vestibule structure must be practically destroyed before the initial resistance of the body end structure is overcome, and the second group of cables called upon to resist further penetration. I believe that only in cases of the utmost violence will the body end of the invaded car be crushed in

strong cable loops in the car structure, produces a collision shock absorber which may be compared to a buffing device in which the maximum length of path of resistance, or travel, is only limited to the confines of the loops engaged instead of limited to a few inches travel. Time will not permit of entering into details of the method of incorporating the cable loops in the car structure. It is the intention, however, that all the structural members be retained by the cable loops within the path of the invading body to make resistance to penetration during the time the loops are being drawn down as great as possible.

In the foregoing description of a car adapted to resist the shocks experienced in sidwiping, derailments and collisions we have naturally illustrated and described the design of car which we have ourselves evolved while guided by a close study of the collection of photographic records of accidents which we have been accumulating for a number of years. Manifestly the cable system of reinforcement can be incorporated in any adequate design of vestibule end and body end construction. I, however, believe that a car embodying the strong superstructure, with strong vestibule and body end construction as outlined above is particularly well protected



Reinforced Body End with Cable Loops

and the ultimate resistance of the main cables be developed. For example, in some of the complete telescoping cases illustrated the initial resistance offered by the vestibule and the body end construction of the invaded car was inadequate to prevent penetration. The secondary resistance offered by the roof structure and the interior fittings was negligible as compared to that which would have been afforded by wire cables of 2,000,000 lb. (1,000 tons) capacity which would have checked the invader at or near the point of entrance. It is my opinion, that in cases of extreme violence, and before the vestibule structures have been completely compressed, the thrust transmitted to the underframe of the invaded car, through the medium of the cables, will be sufficient to impart motion to the standing train and thus dissipate a large proportion of the energy of the collision.

We are all familiar with shock absorbers in daily use, such as rubber heels, pneumatic tires, truck springs, buffing devices, draft gear, etc. All these devices introduce a time element, or path of resistance, commencing at the instant of impact and increasing in resistance until the shock is absorbed or the device becomes solid. The introduction of the

against damage in accidents of the derailment and sidwiping class and further that such a car fitted with the limiting loop of wire cables as described will be as safe against invasion by a telescoping body as now seems possible.

Adjustment of Brake Power on Tank Cars

Some confusion has arisen as to the provisions of circular S. III-11, issued in May, 1919, by the American Railroad Association, Section III-Mechanical, specifying the adjustment of brake power on tank cars. The mechanical division of the American Railway Association has issued Circular S III-193 revising the original instructions.

The original circular states that the minimum average power brake equipment should be 60 per cent of the light weight of the car, based on a cylinder pressure of 50 lb. per sq. in. In order to eliminate the confusion which has been caused by the use of the word "minimum" in connection with the 60 per cent braking power, causing some to believe there is no limit to the maximum percentage of braking power

that may be employed, the paragraph in question has been changed to read as follows:

The recommended practice of the association provides that the air brake power for freight equipment should be 60 per cent of the light weight of the car, based on the cylinder pressure of 50 lb. per sq. in.

The sketches shown in Circular S III-11 specifying the methods of making end brake connections at the cylinder lever, did not clearly indicate that the brake chain should be connected at the top of the drum on the lower end of the brake staff. In the revised circular sketches of the brake chain connections have been shown in which the proper attachment of the chain to the top of the drum or barrel is clearly indicated, and a paragraph clearly specifying this location has been added to the instructions.

Some car owners have endeavored to provide the hand brake power specified by lengthening the piston ends of the live cylinder lever to provide a hand brake connection (instead of by the method specified in Circular S III-11 and the specifications for tank cars, regardless of the fact that by so doing the equalization of the hand brake power on the two trucks is seriously disturbed. In order to cover this point clearly the following paragraph has been added:

Cars are not in accordance with the requirements if (a) the hand brake connection is made to an extension at piston end of live cylinder instead of to the push rod as shown in Figs. 1, 2 and 3, of Circular S III-11; (b) unless the body and truck levers are properly proportioned for the percentage of brake power specified for the air brake, or (c) on which the percentage of brake power for the hand and air brake is not equal on both trucks.

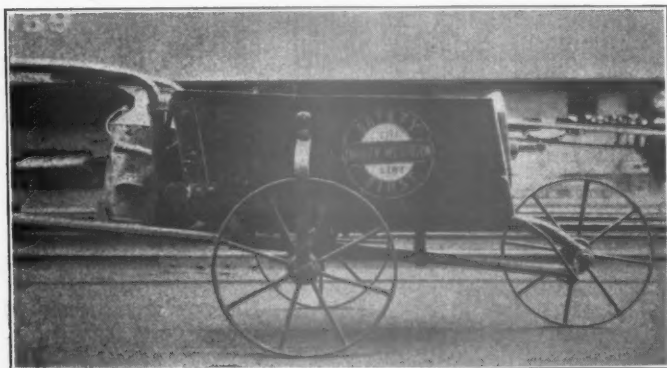
The two sentences in the first paragraph under "Adjustment of Hand Brake Power" in Circular S III-11 have been confused to the extent of considering the second sentence without regard to the preceding one, cases having been reported in which the brake power for the air brake system was less than 27 per cent of the empty car weight. To make these instructions clear this paragraph has been changed to read:

With the body and truck lever properly proportioned to 60 per cent braking power on each truck, as specified in the foregoing, and based on the formulae and diagrams shown herein, the hand brake wheel or the hand brake ratchet lever, brake staff and chain, and the hand brake leverage between brake staff and cylinder shall be so proportioned that a force of 125 lb. at the rim of the brake wheel or 3 in. from the outer end of hand brake ratchet lever will develop an equivalent load W at the brake cylinder piston of not less than 2,500 lb. and 3,900 lb. respectively, for cars having 8-in. and 10-in. cylinders.

Emergency Truck for Car Repairs

BY E. A. AUSTIN

A truck for carrying the materials and tools necessary for making light repairs is a handy device for use at passenger stations. Such devices are not widely used although they

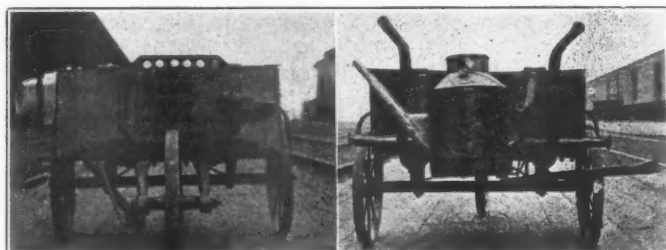


A Side View of the Repair Truck

have proved a great help in expediting work. The type shown in the illustration herewith is used at Milwaukee on the Chicago & North Western. One of the advantages of the design is that it is built low enough to pass underneath cars, being only 27 in. high. This saves the time ordinarily wasted in running around the train in case the work must

be done on the opposite side from that on which the truck happens to be.

As shown in the rear view, a large oil can is carried between the handles of the truck. In the front of the body, there is a jack plate with a goose neck that catches the rim of the wheel and holds it on the rail when jacking up the box to change brasses. The long bar resting on brackets at the side of the truck answers for two purposes. One end is



A Jacking Plate and An Oil Can Are Carried on the Front and Back of the Truck

square for driving in wedges and the other has a point shaped like a parrot bill for throwing over the lateral of the axle or for removing the wedge in case it binds when the car is jacked up.

The interior of the truck has five compartments. Two are used for buckets of prepared packing, one for the journal jack, one for brasses and one for blocking. It is customary to carry one block 3 in. by 10 in. by 24 in., one 1½ in. by 10 in. by 24 in., and an iron plate ½ in. by 8 in. by 12 in., which is convenient to use where there is not sufficient space to get a thicker block under the jack.

Virginian 120-Ton Cars

Among the illustrations accompanying the description of the 120-ton coal cars for the Virginian, published in the March issue, there is a plan and side elevation of the body, which appeared on page 164. Several incorrect dimensions are shown on this drawing. The distance from the center line of the body bolster to the striking plate, should be 7 ft. 3½ in., instead of 6 ft. 11 in. The distance between truck centers should be 36 ft. 1¾ in. and not 36 ft. 10¾ in. Both these dimensions are correctly given in the details of the underframe and draft gear on pages 165, 166 and 167. The wheel base of the truck is shown on the drawing of the car body as 8 ft. 8 in., whereas the wheel base of the Buckeye truck used was 8 ft. 6 in., of the Lewis truck 9 ft., and of the Lamont truck, 8 ft. 3 in.

Strikes on Southern Roads.—A strike was ordered by the labor organization on the Missouri & North Arkansas on February 27, when enginemen, trainmen, telegraphers and station agents left their work. An attempt was made to resume service, but after a time C. A. Phelan, receiver and general manager, issued a statement to the effect that service would be suspended because depredations which had been committed would endanger the lives of passengers and employees.

The Atlanta, Birmingham & Atlantic was placed in the hands of a receiver by Judge Sibley of the United States District Court, Atlanta, Ga., on February 25. Later Judge Sibley signed an order putting into effect the schedule of reductions which Mr. Bugg, president, and later receiver of the road, had urged before the Labor Board. On March 5 a strike was authorized and about 1,500 men walked out. The places of the striking employees were filled as rapidly as possible, and local passenger and freight service was resumed after a short interruption.

Draft Gear Tests of the Railroad Administration

Second of the Series of Articles Describing Investigations Conducted by the Inspection and Test Section

AFTER measuring the test gears and reassembling them with their parts in their original positions, the 9,000 lb. drop tests were made. Except for a few gears that were added at a later date, the original series of drop tests was made at the Mt. Clare shops of the Baltimore & Ohio Railroad. After the car-impact tests at Rochester, the same gears were submitted to a second series of drop tests under the Pennsylvania Railroad machine at Altoona for check purposes.

The drop tests were in all instances made with the gears

The information for plotting drop test diagrams was obtained during the first series of drop tests by causing the tup to drive a nail into the end of a wooden post, the penetration of the nail denoting gear closure for each successive drop. The diagrams have been plotted to the exact points recorded, with no averaging or smoothing up of the curves. The regularity of gear action can thus be seen and in such a test this is of as much, if not more interest than the general trend of the line.

Some of the drop test figures obtained in these tests are

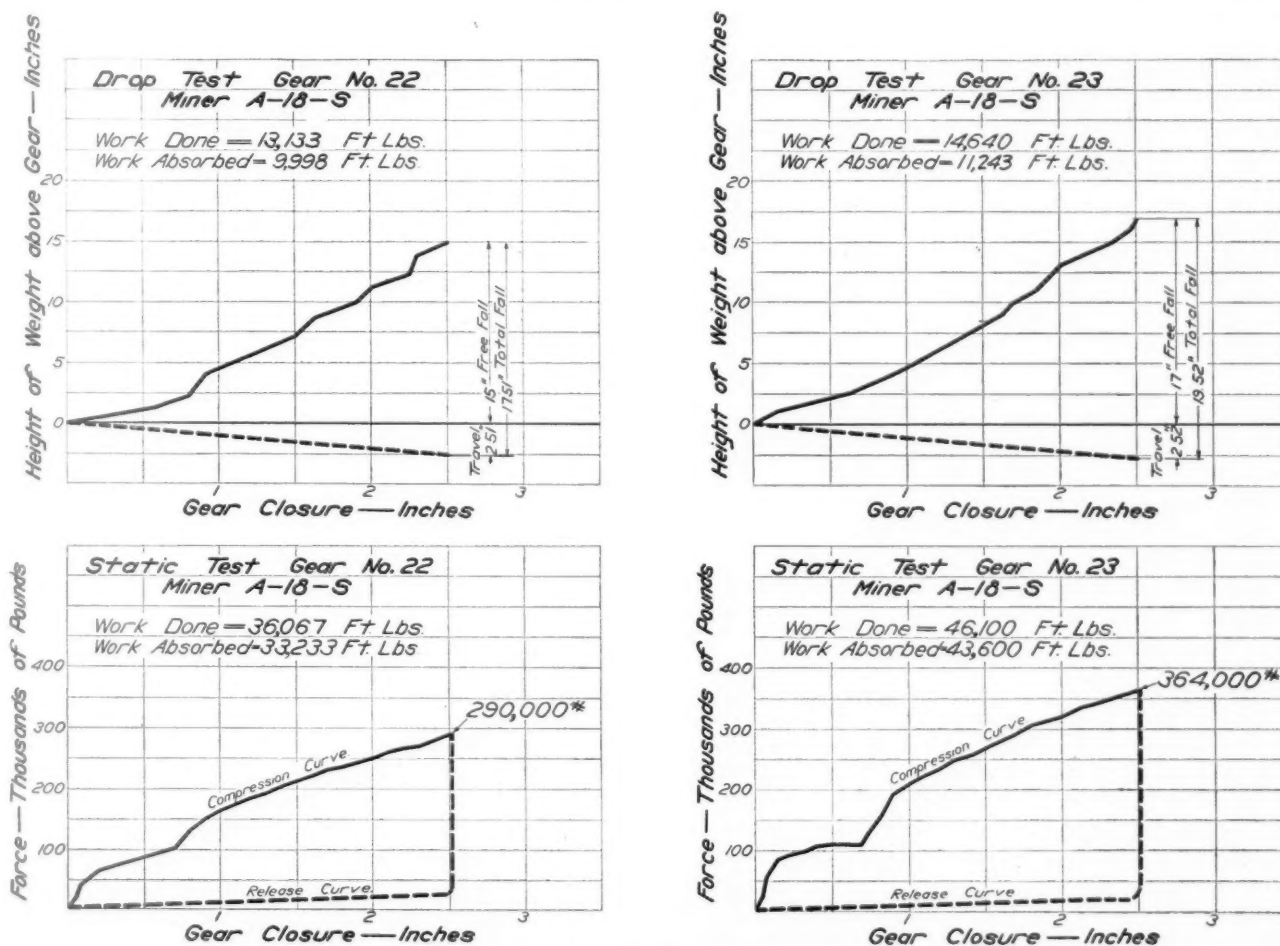


Fig. 2—Typical Drop Test and Static Test Diagrams, Miner A-18-S Gears

supported upon a solid anvil. Before beginning the drop tests of either of the above series each gear was given a certain amount of preliminary work to insure the proper seating of the parts. The uniform practice was followed of first determining the drop test value of each gear, by dropping the weight from 1 in. free fall and then increasing the fall by 1 in. increments, until the closing point was reached. The gear was then given 10 blows from 1 in. below the solid height, which usually resulted in building up the capacity of the gear slightly. After this preliminary work the regular drop tests were made, the tup being again dropped through heights increasing by 1 in. increments until the closing point was reached. In the case of gears such as the Harvey springs the solid point was previously determined from a preliminary static test and this point worked to in the drop test.

higher than usually reported for gears of the same type. The care taken to have all surfaces in good condition and the uniformity of testing conditions insures that the present results are comparable with each other. In general throughout this report the drop tests are reported in terms of "total fall," this being the free fall plus the penetration or actual travel of the gear. Some confusion has existed heretofore in this respect but it is proper to express these results in total fall rather than free fall if the true drop test capacities are to be compared.

The recoil of the 9,000 lb. weight was also measured by means of a special slide on the side of the drop machine. The quantities as tabulated are for the total recoil of the weight above the lowest point reached by it in closing the gear. The drop test capacity, foot pounds of work done, is

accordingly represented by the potential energy in the weight at a height corresponding to the total fall required to close the gear. The energy given out by the gear upon release is denoted by the amount of recoil of the weight. The work absorbed is found by subtracting the energy of recoil from the "work done," or the total energy required to close the gear.

A discussion of the individual performance of the gears in the drop test follows:

WESTINGHOUSE D-3:—The action of these gears under the drop was entirely satisfactory. The initial flatness of the curves shows the result of the preliminary spring action and the curves as a whole indicate that the gear action is reasonably consistent throughout the entire range. The average total fall of the 9,000 lb. tup required to close a new gear of this type, when in good condition, is taken at 19.8 in., and the total recoil of the weight at 3.8 in. These figures are arrived at by averaging all of the drop test results for these gears, the same practice having been followed for each gear unless a statement to the contrary appears.

WESTINGHOUSE NA-1:—The drop test results on these gears are not quite so regular as on the older Westinghouse D-3 gear, but while the diagrams are more irregular, the action in general is good. The results also are considerably higher, hence it cannot be expected to find as regular action as in the lighter gear. No breakage or failure of any kind occurred during these drop tests.

SESSIONS K:—The drop test diagrams for these gears, while not so smooth, are yet good for a gear of such short travel. In two gears the spring barrels began to scale before the gears went solid. Failure of the gears had, therefore, begun before closure and hence the tests are not satisfactory.

SESSIONS JUMBO:—This gear showed considerably more capacity and at the same time more uniform action under the drop test than the previous Sessions K gear. The spring barrel of one gear developed a crack during this test.

CARDWELL G-25-A:—The action of these gears under the drop was good, the diagrams being especially smooth and regular. The cast iron friction blocks formed decided depressions in the malleable iron heads, however, and a crack developed at one corner of one of the friction blocks, while in the final drop tests at Altoona one of the side friction members was broken in halves. The average drop for the test gears of this type is 21.1 in., but as heretofore explained, it is believed that these test gears are not representative, the average drop test results obtained in United States Railroad Administration acceptance tests being 16.6 in. The gear is, therefore, credited with a value midway between these figures, or 18.9 in. total fall required to close an average new gear when in good condition. The average total recoil to be expected is taken at 2.8 in.

CARDWELL G-18-A:—This gear showed smooth and regular action under the drop, and the diagrams are entirely satisfactory. The springs of one gear took a slight set during the drop tests.

MINER A-18-S:—The drop tests of these gears were satisfactory and the diagrams denote especially uniform gear action for all ranges. This is particularly noticeable because of the fact that the gear has a travel of but $2\frac{1}{2}$ in.

MINER A-2-S:—These gears did not show so regular under the drop as the previous Miner gears but the diagrams are good. The drop capacity, however, is low. In one gear the main spring went solid during this test.

NATIONAL H-1:—This gear developed an unusually high capacity under the drop and while the diagrams are not entirely smooth, yet, considering the amount of fall and the short travel of $2\frac{1}{2}$ in., the gear action is good.

NATIONAL M-1:—The drop tests of these gears did not produce diagrams proportionally as smooth as those of the previous National gears, considering their lower capacity.

The diagrams, however, show reasonably uniform gear action.

NATIONAL M-4:—The action of this gear under the drop was very similar to that of the National M-1 just described.

MURRAY H-25:—These gears, while not of high capacity, showed the most regular action of any friction gear tested. The diagrams are unusually smooth and indicate consistent action throughout the full range of the gear. Considerable chafing and wear occurred during the closures under the drop. Unquestionably, this wear would soon deteriorate the gear.

GOULD 175:—These gears showed good action under the drop except for the fact that in each instance the plates of the friction spring took a slight permanent set. The gears showed high recoil and because of this feature it was difficult to keep them in position on the anvil.

BRADFORD K:—The drop testing of these gears was difficult and unsatisfactory. The springs went solid before the heads of the gears came together and two gears failed by splitting the heads. The failures were undoubtedly due to this spring condition, as extremely high forces are set up in this, as in most friction gears, if the springs go solid before the gear is closed. One gear also developed a cracked head during the drop test. It is noticeable that the portion of the head immediately back of the coupler butt, in buffing, is not properly supported. Another serious point is that in several instances the heads pinched and stuck in the frame on release. These gears showed low capacity and high recoil under the drop, their action being very little different from that of a spring gear.

WAUGH PLATE TYPE:—These gears gave reasonably smooth diagrams in the drop test but in each instance the plates took a permanent set. The drop capacity is low and the recoil high. The gear is of especially easy movement at the beginning of its travel.

CHRISTY:—This gear was very erratic under the drop, and the action is not at all satisfactory. The gears as tested were shorter than the pocket dimension and this clearance allowed the wedge roller to get out of position upon recoil. The total fall required to close the test gears ranges from 14.3 in. to 26.3 in. It is therefore difficult to set an average value, but in the absence of better uniformity the three results have been averaged.

HARVEY 8 IN. BY 8 IN. SPRINGS:—Each of these gears as tested consisted of two Harvey 8 in. by 8 in. springs, set side by side upon the anvil. The gears showed but little capacity under the drop, although the action was regular. In the case of one gear the springs took a slight permanent set.

A. R. A. CLASS G SPRINGS:—Each of these gears as tested consisted of two A. R. A. Class G springs, set side by side upon the anvil. The springs showed low capacity in the drop test, but the action was smooth throughout the range of the springs. A summary of the data obtained in the drop tests is shown in Table I.

Static Tests

Immediately upon the completion of the drop tests the same two gears of each type were closed in a testing machine at a speed of $\frac{1}{8}$ in. per minute. Readings were taken for each $\frac{1}{10}$ in. of compression, the closure being continuous, with no stops except where sudden changes in load occurred.

In many gears, when being closed at a slow speed, the resistance will build up at an abnormal rate, and shortly, from some reason such as the elasticity of the parts, a sudden readjustment will occur. In many instances this is accompanied by a loud report that may be best described by use of the word "bombardment." Invariably such readjustment results in a sudden reduction of the load. When a bombardment occurred during the tests, the machine was stopped until a full record of the conditions could be obtained. In plotting the static test diagrams the actual results have been used, all bombardment actions being shown, and no curves

having been averaged or smoothed out, as is frequently done in plotting such diagrams. No gear should be condemned, however, solely because of the presence of bombardments or irregular action in the static tests, for some gears, while showing very irregular static diagrams, and even total failure in this slow test will yet show excellent results in both the drop test and the car-impact tests. Bombardments are conceded to be a normal action of many types of gears in slow static testing.

The car-impact tests show that when cars are coupled at

be compared with service or impact tests. The static is the simplest and the easiest draft gear test to make, and it is probably understood by the average mechanical man better than any other. It is unfortunate, therefore, that it is not more reliable, but as will be seen as the various tests are discussed, it is usually misleading and cannot be employed for comparing the merits of different draft gears.

The practice of rating gears upon a supposed ultimate resistance such as, for example, "a 200,000 lb. gear" or "a 350,000 lb. gear," is to be discouraged. Due to the limited

Make and type of gear 1	Test gear number 2	Static Test Speed of testing machine $\frac{1}{8}$ in. per minute					Drop test			Car-impact test		
		3 in. per min. Ultimate re- sistance, lb. 3	$\frac{1}{4}$ in. per min. Ultimate re- sistance, lb. 4	Ultimate re- sistance, lb. 5	Work done, ft. lb. 6	Work ab- sorbed, ft. lb. 7	Work done, ft. lb. 8	Work ab- sorbed, ft. lb. 9	Computed Ultimate re- sistance, lb. 10	Work done, ft. lb. 11	Work ab- sorbed, ft. lb. 12	Ultimate dynamic re- sistance, lb. 13
		3 in. per min. Ultimate re- sistance, lb. 3	$\frac{1}{4}$ in. per min. Ultimate re- sistance, lb. 4	Ultimate re- sistance, lb. 5	Work done, ft. lb. 6	Work ab- sorbed, ft. lb. 7	Work done, ft. lb. 8	Work ab- sorbed, ft. lb. 9	Computed Ultimate re- sistance, lb. 10	Work done, ft. lb. 11	Work ab- sorbed, ft. lb. 12	Ultimate dynamic re- sistance, lb. 13
Westinghouse D-3	1	189,000	196,000	190,000	18,434	16,400	13,875	11,100	143,000	13,800	11,433	195,000
	2	207,000	212,000	200,000	18,667	16,534	14,625	11,813	157,000	15,533	12,900	240,000
	3						16,125	13,253				
	4			Failed			21,000					
Westinghouse NA-1	5			Failed			22,500					
	6						20,295	17,655				
	7						19,500	16,875		21,417	19,883	158,000
	8						15,000	12,548		16,917	13,550	187,000
Sessions K	9			Failed			15,750					
	10	401,000	443,000	395,000	34,700	32,400	13,628	10,793	155,000			
	11						15,045	11,723		23,733	20,317	260,000
	12						13,545	10,605		15,000	12,433	165,000
Sessions Jumbo	13	318,000	318,000	318,000	32,300	28,450	19,575	15,803	163,000			
	14	504,000	560,000	457,000	61,970	57,000	20,295	16,500	150,000	17,650	13,216	137,000
	15						23,250	18,420		20,400	15,417	250,000
Cardwell G-25-A	16	327,000	381,000	410,000	52,500	51,234	16,313	13,605	128,000			
	17	332,000	337,000	356,000	46,600	43,800	15,563	13,373	120,000	16,233	13,100	295,000
	18						15,563	13,223		19,600	17,967	315,000
Cardwell G-18-A	19	234,000	225,000	240,000	32,400	31,300	15,188	13,823	112,000			
	20	141,000	135,000	146,000	20,100	18,700	13,718	12,968	100,000	14,033	12,417	110,000
	21						15,188	14,033		20,200	18,733	186,000
Miner A-18-S	22	367,000	383,000	290,000	36,067	33,233	13,133	9,998	106,000			
	23	419,000	424,000	364,000	46,100	43,600	14,640	11,243	116,000	22,800	19,167	390,000
	24						16,898	13,245		14,633	7,500	390,000
Miner A-2-S	25	173,000	152,000	146,000	19,500	18,200	10,163	7,290	76,000			
	26	344,000	346,000	289,000	49,833	48,033	10,148	7,283	59,000	11,283	9,733	105,000
	27						9,375	6,533		8,767	7,100	68,000
National H-1	28	472,000	330,000	215,000	10,333	7,900	23,648	20,190	492,000			
	29	541,000	528,000	600,000			24,375	20,775		25,867	20,500	390,000
	30						22,125	19,148		28,500	21,000	550,000
National M-1	31	487,000	493,000	518,000	43,933	42,067	13,890	11,535	164,000			
	32	461,000	414,000	550,000	62,267	58,467	13,898	11,483	122,000	23,033	20,333	400,000
	33						15,398	12,690		16,967	13,234	218,000
National M-4	34	442,000	435,000	358,000*	34,600	32,167	14,655	13,058				
	35	412,000	387,000	349,000*	28,330	26,300	17,595	14,265		20,633	19,283	159,000
	36						16,148	14,408		16,300	12,350	138,000
Murray H-25	37	241,000	242,000	246,000	18,767	16,600	13,238	10,478	174,000			
	38	207,000	204,000	206,000	17,500	15,900	12,323	9,795	145,000	14,800	12,867	210,000
	39						12,603	10,208		13,000	10,300	130,000
Gould 175	40	267,000	280,000	253,000	20,700	17,167	13,785	8,025	169,000			
	41	261,000	258,000	250,000	19,667	16,934	13,080	7,875	166,000	12,567	8,067	260,000
	42						13,875	8,408		14,967	12,133	230,000
	43											
Bradford K	44											
	45	104,000	101,000	103,000	6,450	2,083	8,588	4,530	137,000			
	46	82,000	81,000	85,000	5,367	1,333	6,330	2,438	84,000	7,333	2,883	270,000
	47						9,330	6,242		6,333	1,417	220,000
Waugh Plate	48	187,000	181,000	200,000	9,900	4,967	10,628	4,598	214,000			
	49	148,000	144,000	150,000	7,300	3,867	9,938	4,500	204,000	7,767	2,733	335,000
	50						10,688	4,523		10,433	5,500	285,000
Christy	51	194,000	180,000	163,000*	16,300	15,033	10,740	8,228				
	52			600,000			13,658	9,938		12,300	10,317	194,000
	53						19,710	15,308		13,567	11,500	150,000
Harvey 2-8 by 8 Spgs.	54	364,000	380,000	430,000	10,400	5,400	5,910	3,130	244,000			
	55	377,000	361,000	382,000	7,667	4,134	8,070	4,688	402,000	5,900	4,317	245,000
	56	393,000	409,000	458,000			7,373	4,208		4,083	1,100	300,000
	57			59,000			4,373	1,253				
Coil Springs 2.8 by 8 Class G.	58			56,000	3,567	434	4,275	1,215	67,000	3,900	600	60,000
	59			60,000	4,034	434	4,283	1,200	64,000	4,333	300	60,000

Table II—Comparative Ultimate Resistance of Gears in Static, Drop and Car Impact Tests

a velocity of four miles per hour, each of the two opposing draft gears begins to close at a rate of 2112 in. per minute (176 ft. per min.) and that the closing rate gradually falls off until it is zero at the point of maximum gear closure, this corresponding with the point where both cars are of equal velocity. The average rate of closure at four miles per hour impact is approximately 1400 in. per minute; the static test rate of $\frac{1}{8}$ in. per minute exists for less than 1/100 in. of gear movement. Results of slow static tests cannot, therefore,

travel of draft gears it is necessary that the ultimate resistance of the gear be high if cars are to be handled at switching speeds above two miles per hour. The manner in which this ultimate resistance is reached is of great importance. It will be seen in some of the static cards that while the ultimate resistance is high, yet at the beginning of the diagram it is extremely low and becomes really effective only during the last quarter of the diagram. This means not only that the gear is of low capacity for its ultimate resistance, but that

the final rate of building up the force is too high and will set up undesirable vibrations in the car structure. The ultimate resistance of a gear cannot, therefore, be wholly indicative either of capacity or of cushioning value, capacity being a product of the average force and travel, and cushioning being dependent upon the rate of building up of the force as well as the magnitude of the force itself.

Static test diagrams were plotted for closures at the rate of $\frac{1}{8}$ in. per minute. The same gears were also partially closed at the rate of $\frac{3}{4}$ in. per minute and at an average rate of 3 in. per minute, for comparison. These three closures were made in immediate succession so that the condition of the gear had not changed.

Because of the fact that the results of static tests are not indicative of the action of the gear under service conditions, the discussion of the individual performance of the gears in the static test, which was included in the report, will be omitted. The results of the tests are given in Table II. For comparison there are shown also the results obtained in the drop test and later in the car-impact tests. Part of this table requires some explanation.

Column 3 gives, for a closing speed averaging 3 in. per minute, the ultimate or maximum resistance of the gear at the point where the gears just closed or where normal gear action ceased. Columns 4 and 5 give the ultimate resistance, at closing speeds of $\frac{3}{4}$ in. and $\frac{1}{8}$ in. per minute. An asterisk

being at a constant speed and the drop and car-impact closures beginning at a high speed, which gradually reduces to zero at the point of maximum closure. In the car-impact tests, with a gear in each car, the gears begin to close at a speed not less than 1056 in. per minute at two miles per hour impact, or 2112 in. per minute at 4 M.P.H. impact. In the drop test, with a 15 in. free fall, the gears begin to close at a speed of 6458 in. per minute or 9130 in. per minute at 30 in. free fall.

9,000 Lb. Drop Tests—Friction Surfaces Coated with Foreign Material

It has been repeatedly noticed when taking down gears in car repair yards that the friction surfaces, while usually worn to a good bearing contact, are not in the same clean and perfect condition as that of protected test gears. On the contrary, there is frequently found an actual coating or glazing of hard, black material that can sometimes be scraped off with a knife. This is probably an accumulation of particles of metal, coal dust and rust.

In order to obtain some knowledge of the effect of foreign material upon the friction surfaces, one of each type of gear was taken apart, after completing the original drop and static tests, and the friction surfaces were dampened and sprinkled with a mixture of pulverized coal and iron rust. The gears were then reassembled with the parts in their original posi-

TABLE III—PERFORMANCE OF GEARS WITH COATED FRICTION SURFACES (DROP TEST)

Make and Type of Gear	Test Gear Number	Total fall in inches of 9,000 lb. weight to close					Remarks
		In original condition	With coated surfaces		First closure after cleaning surfaces	Number of blows required to restore gear to original capacity after cleaning surfaces	
			First closure	After twelve blows			
Westinghouse D-3.....	1	18.50	10.50	10.5	11.5	18	
Westinghouse NA-1.....	6	27.06	13.06	14.06	14.1	41	
Sessions K.....	10	18.17	8.2	9.2	13.2	15.2 in. after 30 blows	Gear could not be fully restored.
Sessions Jumbo	13	26.10	16.1	16.1	21.1	25.1 in. after 35 blows	Gear could not be fully restored.
Cardwell G-25-A	16	21.75	15.75	12.75	18.8	28	
Cardwell G-18-A	19	20.25	13.25	17.00	17.75	30	
Miner A-18-S	22	17.51	11.51	11.51	12.5	40	
Miner A-2-S	25	13.55	7.55	7.55	10.6	27	
National H-1	28	31.53	15.5	17.5	17.5	34	
National M-1	31	18.52	9.52	13.52	13.5	17	
National M-4	34	19.54	8.54	14.50	18.00	4	
Murray H-25	37	17.65	9.7	10.7	11.7	54	No hard coating on surfaces as in other gears, but considerable wear.
Gould 175	40	18.38	11.4	11.4	13.4	52	
Bradford K	45	11.45	9.5	9.5	10.5	11	
Waugh Plate	48	14.17	11.2	11.2	11.2	12.2 in. after 15 blows	Gear could not be fully restored.
Christy	51	14.32	9.3	9.3	10.3	30	
Harvey 2-8 in. by 8 in. springs.....	54	7.88	5.9	5.9	6.9	13	

(*) in any of these columns denotes that the maximum resistance as tabulated was developed before the gear was closed, a bombardment or other cause reducing the resistance at the point of closure. It will be understood that the capacity of the testing machine would not admit of complete closures at the 3 in. and $\frac{3}{4}$ in. speeds. The results have been extended proportionately, however, so that the tabulated results represent complete gear closures.

Column 10 gives a computed resistance for the drop test. This figure has been obtained by proportioning the resistances to the foot-pounds of work done in these two tests. Thus in gear No. 1, the static test at $\frac{1}{8}$ in. per minute gave an ultimate resistance of 190,000 lb. with 18,434 ft. lb. of work done. In the drop test the work done was 13,875 ft. lb.; hence on the same basis the ultimate gear resistance is 143,000 lb. The figures in this column, therefore, although purely hypothetical, are of interest. If the static card is indicative of the dynamic force curve, then the results in Column 10 are approximately correct, for inasmuch as the one leg (gear travel) is the same in both diagrams, the other leg (resistance) should be roughly proportional to the area, or work done.

The resistance figures given in this table represent a variety of speeds and conditions of gear closure, the static closures

tions and the dampness allowed to dry out. Each gear was then put under the 9,000 lb. drop and the closing point determined in as few blows as possible, and the gear then given 12 blows at or just below the closing point.

The gear was then taken apart and the free material wiped off with clean waste. In almost every instance the friction faces were now found to be covered with a hard, glazed coating similar to that found in service. This was removed with clean, sharp sandpaper and the surfaces again wiped off with clean waste. This in every instance left the friction surfaces in as perfect looking condition as could be desired. The action of the gears immediately after this is therefore especially interesting, as in almost every case the careful cleaning of the surfaces did not increase the capacity, and quite a number of blows were required to restore the gears to their original capacities. In several instances it was impossible to entirely restore the gears. Any gear might by this method be made to show an extremely low capacity, even though all parts of the gear were of full size and to gage and the friction surfaces apparently in perfect condition. At the same time, an inferior gear could be in apparently no better or more favored condition and yet show decidedly higher results. Table III. has been prepared to show the results of this test.

Car Inspectors and Foremen Propose Changes in Rules

Members Recommend Revisions in Interchange Code for Consideration of A. R. A., Division V.

AT a meeting of the Executive Committee of the Chief Interchange Car Inspectors' and Car Foremen's Association of America, held at the Hotel Sherman, Chicago, March 3 and 4, proposed changes in the A. R. A. rules of interchange were taken up, thoroughly discussed and many of them approved for the consideration of the proper committees of the Mechanical Division of the American Railway Association. At the annual meetings of the Executive Committee, held for the purpose of discussing and recommending changes in the interchange rules, it has been customary for members of the Executive Committee only to vote. This meeting, however, was attended by about 100 members of the association, and a motion was adopted that all members be permitted to vote. The meeting was called to order by J. J. Gainey (Southern), chairman of the Executive Committee, who presided at all the sessions.

Elimination of Delivering Line Defects

One of the outstanding features of the meeting was the resolution presented by C. J. Wymer, superintendent car department, C. & E. I., recommending that the rules of interchange be revised to eliminate all delivering line defects, making the owner responsible for all repairs except those due to accident; that the standard prices for labor and material be fixed high enough to afford the repairing line a substantial profit, and a per diem or rental charge be fixed high enough to reimburse the owner for his investment and the cost of maintenance.

Mr. Wymer's resolution, which was offered at the beginning of the first session, after being discussed at length, was revised by a committee, and finally lost by a vote of 32 to 16. The resolution, as revised by the committee, is as follows:

Whereas, The present interchange code of rules of Mechanical Division V of the A. R. A. in our opinion does not meet present day requirements for handling and maintenance of equipments, and does not sufficiently facilitate the movement of traffic; be it therefore

Resolved, That these rules should be revised, eliminating all delivering line defects, making all necessary repairs chargeable to car owners, except badly damaged cars due to accident on which a limit of repairs chargeable to owners should be provided. A limit to the cost of repairs due to owner's defect should be maintained, owner to advise disposition of car within a specified time, this time to be determined.

Resolved, That the prices for labor and material should be sufficient to afford the repairing line a substantial profit.

Resolved, That if the changes recommended are adopted, the per diem or rental charge should be sufficient to insure the car owner a fair return on investment, which would include interest, taxes, insurance and depreciation. Per diem or rental should include cost of maintenance.

The motion to adopt the resolution was seconded.

A. Herbster (N. Y. C.): This will automatically do away with defect carding. It will eliminate a whole lot of our troubles that we have had in the past. I have not heard anything from Mr. Wymer regarding fire damage, and nothing has been brought up regarding cars being in a flood. On the whole, I think his resolution is a very good one.

A. Kipp (N. Y. O. & W.): It looks to me as if there is altogether too much money involved at the present time to have the railroads of this country adopt any such system. We have not gotten to the point yet where the car owner wants to be, and will be, entirely responsible for the repairs to his cars. Until that time arrives or our equipment is in different shape than it is today, I do not think that a resolution of this kind would be considered by the Arbitration Committee.

F. H. Hanson (N. Y. C.): I think it is a move in the right direction, although probably we are a little hasty in recommending to the extent that Mr. Wymer has suggested. I believe certain modifications should be made in order that

our superiors and the Arbitration Committee may sit up and take notice, because there seems to be a tendency now instead of changing a rule now and then each year and making the car owner responsible for more defects to do the pounding all at one time.

J. J. O'Brien (T. R. R. A.): Mr. Wymer, no doubt, has given consideration first to Rule 1, which we all know in the mechanical department no railroad in this country is living up to. Without conforming to that rule, all of the other rules do not fit in. It is very unfortunate that rules which have been gotten up by the Master Car Builders' Association, with good intentions and a spirit to carry them out, cannot be lived up to because of the lack of men and facilities necessary to keep the equipment up.

We have to take another point into consideration. The Car Service Section has formulated rules on the theory that Mechanical Division rules are not going to be conformed with, and, as a result, there is a conflict and always will be. The Car Service Section imagines that all cars are fit for service, and, in reality, approximately 75 per cent are defective and not fit for the commodity for which they were built.

Probably some modification could be made to that resolution, but the intent is good, and it is food for thought for the Arbitration Committee.

C. J. Wymer: It will be observed that the third section of this resolution provides a per diem or rental charge sufficient to protect the car owner which should remove the objection made by some of the members who have spoken. The first section would have the effect of saving an immense amount of stationery, time of car inspectors, time of clerks and time of officers which is required in carrying out the present provisions of our rules and in settling the controversies which arise under them. This labor could be expended in more substantial ways, and the officers, as well as clerks, could give their time to more important duties; the car inspectors could devote their time to repairing more defects and looking for defects which are vital. In interchange the car inspector is more interested in finding the defects which may penalize his railroad with a defect card than he is in finding the things which might cause an accident on your railroad. I believe the inspection should be confined to providing for the safety to train men, safe handling of the equipment and protection to the commodity. No doubt much of the time of inspection could be eliminated. Forces could be reduced because of the time now consumed in making all of these records for protection purposes.

The portion of the resolution relative to the charge for labor and material being sufficient to provide a substantial profit for the repairing line would effect better maintenance of equipment. The owning road would be interested in keeping its cars in repair and thereby preventing the expense which would be involved if repaired on foreign lines. On the other hand, it would be an incentive for the railroad which had a foreign car on its line needing repairs, to make the necessary repairs in order that it might avail itself of the profit. It would also have a tendency to improve the construction of equipment so that it might be maintained at the minimum cost.

The provision for the per diem charge is an absolutely necessary feature in order to protect the company owning the cars. Otherwise there would be no incentive to own cars; it would be profitable to operate with the other man's cars, and it would work a material hardship on the large

car owner who would necessarily have to be protected in a regular charge. I brought out in the resolution that the private ownership of cars should be equally protected in the way of return for the use of their money.

A. Kipp: Mr. Wymer speaks of the rental or per diem charge reimbursing the car owner for these repairs that he is going to make the car owner responsible for. At the same time he speaks in his resolution of the price for labor and material, encouraging the foreign line to make repairs. If the per diem is sufficient to take care of all of that for the owner, I cannot see where the incentive is for a road to take its neighbor's car into its shop and thoroughly repair it. While the car is being repaired, the repairing line is paying the owner a rental charge sufficient to take care of any repairs that may be made. Today the roads of the country are pretty generally trying to get rid of the foreign cars on account of that per diem charge. If a road pays that \$1.10 per day for 100 or 150 days and then makes \$100 or \$150 worth of repairs to the car, I can not see where the repairing line is going to get very much out of it.

F. W. Trapnell (Kansas City, Mo.): The railroad without any cars would fare mighty well against one that had a lot of cars. It seems to me in order to go into a deal of this character, it would be necessary to equalize the equipment of the country between all lines. Parts of our country have more business than they have cars to handle, and the roads are using everybody's cars. It seems to me that if everything was made the owner's responsibility and, covered in a per diem charge, it would be hard for those roads to do business.

J. P. Carney (M. & C.): I favor the idea personally, but I think we should go at it more moderately. I think the day is coming when all of the repairs will be thrown into a pool and pro-rated on the basis of the number of cars owned by the different railroads. As a matter of fact, we are all spending a lot of money, and when we get through one hand washes the other if we are honest in the matter. I would be in favor of making everything the owner's defects with the exception of Rule 32.

C. J. Wymer: Mr. Kipp mentioned this incentive. I am not surprised at that point being raised, but the two departments are separate, and I believe the mechanical department would take advantage of the opportunity of repairing cars at a profit. As to the great stock of material, I do not think that affects the matter any more than at present. The change in the rules does not obligate a railroad to carry such stock any more than they do now.

Mr. Trapnell seems to have overlooked the fact that the per diem or rental charge would pertain to large car owners, which I intimated was absolutely necessary to be provided along with this change in the interchange rules.

Mr. Koenke (Indianapolis Refining Company): What does this committee expect to do with privately owned equipment under a report of this kind. You speak of per diem while a private car moves under mileage.

H. W. L. Porth (Swift & Co.): The resolution embodies the word "rental" which would mean mileage.

The motion to adopt Mr. Wymer's resolution was lost.

M. W. Halbert (Chief Inspector, St. Louis, Mo.): The following recommendation for changes in A. R. A. rules, Mechanical Section III, was adopted at the meeting of the St. Louis Car Foremen's Association on Tuesday, March 1:

Rule 2, Paragraph 2—Change to read as follows:

"Empty cars offered in interchange for loading must be accepted if in safe and serviceable condition, receiving road to be the judge. Owners must receive their own cars when offered home for repairs at any point on their line, and foreign cars previously delivered by them at the point where originally delivered, subject to the provisions of these rules."

Eliminate paragraphs F to G, inclusive.

Reasons: It is felt by an investigation of actual conditions that by placing responsibility for transfer on the receiving line, many less cars will be transferred and more cars will be repaired under load without the necessity for transferring.

Eliminate paragraphs I and J.

Reasons: Unnecessary if recommended change in second paragraph is adopted.

A motion to recommend the proposed changes in Rule 2 was made and seconded.

A. Herbster: The chief joint inspector has this proposition under his thumb. If he does not want a car transferred he makes the receiving line repair. I do not believe the change of this rule will eliminate any transferring.

M. W. Halbert: I am not putting these rules up from the chief inspector's standpoint; I am putting them up for the Car Foremen's Association of St. Louis. The recommendations will eliminate a whole lot of trouble that you are having at large interchange points.

J. P. Carney: I would like to ask what that trouble is.

M. W. Halbert: As long as you pay a man for transferring a car, he can transfer for most any technical defect that could be repaired under this resolution.

J. J. O'Brien: We all know that inspection of cars is not made prior to delivery as it is upon receipt. Every one figures he will pass it to his neighbor regardless of the condition. Penalization has never accomplished anything, and the Master Car Builders, as the years have gone by, have decreased the penalization until they have gotten to the point now that the principal penalization is like Rule 32 and the transfer.

This transfer system in vogue at present has decreased the repairs to equipment and placed the responsibility mostly on the traffic or transportation department. The methods generally pursued of transferring rather than attempting to repair has resulted in less facilities and less men engaged in repairing. If the transfer of cars was placed under the jurisdiction of the mechanical department we know that the mechanical department, before it would transfer a car, would exercise good judgment and repair at least seventy-five per cent of the cars being transferred today. I know of a line that has reduced its transfers by placing them under the Mechanical Department, from fifty to seventy-five per cent. I am heartily in favor of this proposed resolution.

J. P. Carney: I agree with Mr. Halbert, but I believe there ought to be something more in the proposed change. We are paying a lot of money for interchange inspection and supervision that some roads are ignoring entirely. You deliver an empty car that a chief joint inspector says is all right and another road will return it. We have delivered cars for a certain load and have called in an outside party who said the cars were all right and the receiving roads have said they were in bad order and have returned them. We ought to change that rule to read so that we can get the chief joint inspector or his assistants to decide whether that car should be returned to the delivering road.

A. Herbster: If we figure on this change in the rule the A. R. A. will have to change Car Service Rule 14. They are the ones that place the responsibility for cost, not the mechanical department. The mechanical rules only tell us when we can transfer a car, therefore I do not believe that the resolution is in order.

Secretary Elliott: The mechanical division tells us when we can transfer a car and get paid for it, not when we can transfer it. That resolution takes out the feature of getting paid for it. If you want to transfer it, that is your own business.

M. W. Halbert: A great amount of money is expended every year on claims. Every time you transfer a car, no matter what commodity it is loaded with, you have a claim. I have heard it said that there were over \$105,000,000 worth of claims paid in 1919. Why not make the necessary repairs if possible and let the car go forward instead of transferring it and getting the claim presented against you, or holding the car up and making the delay?

C. M. Hitch (B. & O.): Nothing has been said so far relative to the loading line loading rotten cars to offer to his connection. When you make the receiving line responsible for the cost of transfer it is more an incentive to cause a bad

car to be loaded and imposed on the receiving line than it is to have the delivering line responsible for the transfer. I do not agree with the move to make the receiving line responsible for the cost of transfer; neither do I agree with Mr. Carney's suggestion to change Rule 2 to give the joint inspector sole authority to return empty cars. I believe the A. R. A. will continue to have the receiving line the judge as to what it will accept and run over its railroad.

A. Kipp: I heartily agree with Mr. Hitch so far as the delivering line is responsible for the transfer. Mr. O'Brien said that if the mechanical department was responsible and made to transfer the cars it would make fewer transfers. That is one of the arguments that our operating department put up to the motive power department. After quite a fight they put the transfer of cars over onto the motive power department. We are keeping a very accurate account of the transfers and find now that we are transferring even more cars than we were when the operating department was transferring. The rules strictly specify what defect shall be repaired under load and the A. R. A.'s tell us for what we can transfer and have the delivering line pay the transfer. We should cut down the transfers as low as they can possibly be cut down. That is what we are doing on the road I am with. We are not transferring anything that can be repaired under load, whether it is a reparable defect under load or not. We pay no attention to that whatever. Our foremen all have instructions that if the car can be repaired under load to repair it.

J. J. O'Brien: There should be more cooperation between traffic and mechanical departments. All of the loaded cars originated through traffic and solicitation, on the theory that the cars will move to destination. If the car passes through a territory where they have good facilities and men to keep it in repair, it proceeds. If, however, the car goes along a line where they have no facilities or men, it is transferred. The railroads today are willing to accept freight in a wheelbarrow or by wagon load; when they get it by the car-load, simply because they haven't the facilities to make repairs, they want to transfer.

A. Herbster: I think Mr. O'Brien is putting the mechanical department in the wrong light. We all know that some cars must be transferred because they cannot reasonably be repaired under load, and that will go on as long as the railroads run. But I do not believe any road is doing the transferring on a wholesale order. I know it is not done on any point with which I come in contact. If we come up against a localized condition, that ought to be remedied at the point where it is happening. I cannot see that the change of this rule will change anything.

W. K. Gonnerman (B. & O.): The railroads are equipped at various points to handle the repairs under load. I know we are and I believe each railroad is in the same position. I am opposed to eliminating the penalties for transferring.

P. M. Kilroy: I am in favor of the change recommended by Mr. Halbert: It is true that the matter is under the chief interchange inspectors at all of the large interchange points, but you would be surprised if you were to follow up each one of those points and see just what a variation there is. Every car transferred at the present time is an absolute waste. Even the railroad that gets paid for the transfer is losing money, especially if that railroad is letting their transfers out on contract.

I have tabulated the number of cars transferred at the large interchange points during the last six months of 1920 and it is astounding to see the difference. Some points exceed others by over 2,000 per cent. At one interchange point, I am glad to say there were only forty cars transferred and those forty cars represented twenty-eight different railroads, so the rotten condition of the equipment that has been loaded is not confined to any particular railroad, to any particular section of the country or to any

particular type of car. At least one of the cars that was transferred was built during the Railroad Administration period. Out of 25,000 cars interchanged at one point under load, there were 24 transferred. Out of 22,500 interchanged at another large point, there were 40 transferred. Out of 25,000 at another very large interchange point, there were 394 transferred and some 76 or 78 adjustments. They were all handled under the same ruling. The cars moved practically toward the same points. There are a great many railroads at the present time that are transferring cars to save per diem.

At least two cases that came under my observation within the last month will bear repeating. One car was transferred at the St. Louis gateway and the road doing the transferring had to pay a claim of \$118 for damage to the freight they transferred. There was another case which you might think was caused by carelessness. The railroad doing the transferring was presented with a claim for \$1,550.

If this change proposed by the Car Foremen's Association of St. Louis will make for uniformity and tend to eliminate any of the things that I have mentioned, it is a step in the right direction.

C. M. Hitch: I have had experience where we had so-called repair transfer at receiving line's expense and it did not lessen the transfer at the particular points involved, but increased and encouraged the loading of undesirable equipments. I am not in favor and never have been in favor of imposing on receiving line the cost of transfer for the reason that I do not feel they are transferring cars for fun. I do not see that they make a dollar in transferring cars; it is for the protection of the property at stake.

P. M. Kilroy: Unquestionably nobody wants to tell any railroad what it shall handle. The receiving line should be the judge of what it shall run. But I most certainly do know that transfers are not being made from a safety standpoint only. If you want to go on the ground yourself and look into it, you will know that the transfers are being made on purely technical grounds to avoid the running of the other fellow's cars. Let us assume that the receiving line takes a car and moves it up to one of their repair tracks and they find that the draft bolts are broken. They have either got to transfer that load or apply the draft bolts. If they apply the draft bolts, they get paid for it; the owner is responsible. But doesn't the line handling that car also reimburse for removing and replacing the load to apply the draft bolts? They are sending those cars back at the interchange point and a great many of them are doing this transferring for the reason that they have no facilities for making the repairs and they are taking advantage of the transfer rules to get those cars off their rails.

Mr. Owen (C. I. I., Peoria, Ill.): We have a small interchange at Peoria and we have a special agreement that the receiving line is responsible for repairs that can be made within twenty-four hours of A. R. A. labor. I believe that would be a good thing to incorporate in the A. R. A. rules. We are not having any trouble and we are transferring only for safety.

H. W. L. Porth (Swift & Co.): It seems to me the elimination of paragraphs F to G inclusive is a radical move. Possibly parts of those paragraphs should be eliminated but the elimination, for instance, of the first two clauses of paragraph F would be rather drastic. The elimination of clauses four, five, six and seven will be also.

M. W. Halbert: If the resolution is adopted, of what benefit would paragraphs F to G be? Eliminate the whole business.

C. J. Wymer: The thing I fear in this resolution is the lack of attention given to the condition of cars before loading. We might find that our transfers would increase rather than diminish.

The first sentence in paragraph 2 of the rule is changed

by the insertion of "for loading." I do not see that that improves it in the least, as they must be accepted now whether they are loaded or empty. This only provides for the acceptance of an empty car for loading and there is nothing said about the car that might not be for loading.

Secretary Elliott: The Car Service Rules take care of the good cars; we are only legislating for the bad order cars. That would be taken care of under the Car Service Rules.

Chairman Gainey: Mr. Hitch says that this allows for the loading of bad order cars and the giving of them to the other men. We are not going to load bad order cars and haul them over your own lines to give them to somebody else. I want you to bear that in mind before you vote. The man that is loading a car is for safety first all of the time if he is living up to what he should do for his country.

C. M. Hitch: I wish that I could feel that all lines would do that, but they do not.

T. P. Carney: There are a lot of roads that get cars that do not want to run a foreign car and they won't do it. If they have a draft bolt broken they call on the chief interchange inspector to give them a transfer and he has to do it under the rules. How can he get out of it?

W. J. Stoll (C. I. I., Toledo, Ohio): In Mr. Halbert's resolution he said that empty cars that have previously been delivered must be received back, subject to the provision of the rules. I do not believe in that. If you give the delivering line a chance to load the cars in bad order, then try to compel the receiving line to run it, he cannot get rid of it until it is empty. I am opposed to that part of the resolution.

P. M. Kilroy: I do not like the insinuation, either implied or direct, that anybody here is going to operate a car over their railroad that is liable to cause an accident. Some of us know that there are a great many transfers that are unnecessary. The railroad that I represent has a record of loading a car and moving it into St. Louis, taking it South, loading it and moving it back as many as five different times and it had five transfers issued against it. I think the car is still running. Would you call that necessary? I am trying to look at this thing from a revenue standpoint.

A. S. Sternberg (Belt Ry. of Chicago): Cars are in bad condition and it is generally conceded that there is occasionally a bad car sent in, but cars placed in industries are inspected very thoroughly. I know they are on our railroad and I believe they are on all railroads in the city of Chicago. None is loaded unless it is fit to carry the load. Why is it that a car will pass over two or three different railroads with a little defect, possibly with a split center sill with draft bolts good, go on another road without any trouble, the defect not being any worse than it was when it originated, and then be transferred against the delivering line? There are a lot of those transfers every day. The change proposed by the Car Foremen's Association of St. Louis will eliminate all such trouble. I believe there are more cars transferred today than during Government control, when the receiving lines did the transferring at their own expense.

A. Kipp: I do not believe that anybody is transferring cars that ought not to be transferred or that are safe to move over their lines. In all of the argument that I have listened to, this condition seems to exist at one particular point and that seems to be St. Louis. I do not see what we have to do with this transfer cost anyway. If we did anything, we should simply modify Rule 2 and say that we can make more repairs under load. The A. R. A. says who will be responsible for the transfer of the load after we tell them what defects we can repair under load. If we have not enumerated enough defects reparable under load, let us add some more.

I move that this resolution be laid on the table until our next regular meeting for discussion.

The motion was seconded.

H. W. L. Porth: There possibly may be trouble, not only in St. Louis, but in a lot of other points where railroads are transferring cars where they have no license to. I personally know that it is being done. But I agree with Mr. Kipp that they should increase rather than decrease the defects that should be repaired under load. If you eliminate paragraph F, aren't you going to decrease rather than increase them?

M. W. Halbert: If the receiving line were responsible for the transferring of the load, of what benefit would paragraphs F to G inclusive be to the receiving line? It is optional with the receiving line to make those repairs or any repairs they can possibly make without the transfer.

Chairman Gainey: I was on a committee for a week that checked up a terminal—every road in that terminal. There were fifty per cent of the cars sent in at the transfer that should not have been transferred. In one of the terminals which I visit, our transfers will run about fifty cars a month, with just as many if not more railroads than another terminal that I visit where we have eight and nine hundred transfers a month. There is something wrong when you get from fifty to nine hundred cars, with more railroads in the terminal with fifty transfers than there are where the nine hundred are transferred.

M. E. Fitzgerald (C. & E. I.): I cannot yet see how any money is going to be saved for the companies by adopting this rule. It will be a matter of education by the representatives of the various lines after you pass the resolution; they will tell their inspectors that we are now responsible for the transfer of cars and they will have to run certain cars because the transfers will not be permitted under the rule. That can be done just as well now. Tell your men that you will not transfer a car for draft bolts or certain other defects. If this resolution is adopted, there is still no instruction in the book to the inspector on what he will do.

The motion to lay on the table was lost.

The motion to adopt the proposed change in Rule 2 was lost.

J. J. O'Brien: I think the right method to use in handling this would be for this body to appoint a committee large enough to be representative of the different sections of the country, to come back this afternoon or tomorrow with recommendations of whatever corrections are necessary in this rule. I do not believe that it is proper to accept that resolution as a whole and present it as the recommendation of this body, but there are very many good points in it and there are some that have not been discussed.

One of them is right in the first paragraph of Rule 2 which outlines the delivery of a foreign car by a railroad to a connecting carrier. That has not been discussed except by Mr. Stoll.

Mr. Owen: The second paragraph of Rule 2 covers the return of cars to the delivering line after transfer or unloading if in the same general condition. If I would deliver you a car and it was necessary to transfer it and you did further damage or smashed the car up, why should I be obliged to take that car back if it is not in the same general condition? My facilities for repairing might not be as good as yours and I believe that the second paragraph of Rule 2 should stand.

On motion, a committee of 14 members was appointed to consider what changes in Rule 2 should be recommended, and report at the afternoon session.

The committee reported unfavorably on the recommendations of the St. Louis Car Foremen's Association, but, by a vote of two to one, with only three members voting, proposed that a limit of 24 man hours be placed on the repairs

for which no transfer should be made at the expense of the delivering line.

F. W. Trapnell: The 24 man hours was not to include any of the cast steel parts that had to be repaired, such as bolsters or truck sides. Those will not take any part of the 24 one man hours.

Mr. Jameson (Southern): I would like to know what the committee means by 24 man hours; does it mean on the M. C. B. schedule, or does it mean in a man's judgment that he can repair in 24 hours?

C. M. Hitch: As the motion was put in the committee it was understood that the 24 man hours would be based on Rule 107.

J. J. O'Brien: The object of submitting that proposition to this body was to encourage repairs to equipment and discourage the transfer of cars that could be repaired within a limited time, and it is felt that it is the duty of the mechanical departments of railroads to assist in the movement of traffic by exerting a certain amount of hours in repairs to equipment rather than to transfer, in which they spend more than the ordinary 24 hours.

Mr. Armstrong (C. I. I., Atlanta, Ga.): Who is going to determine whether the car can be repaired within the 24-hour limit? Isn't it going to be left up to the judgment of the men who inspect the cars for transferring?

P. M. Kilroy: I believe any man in the room pretty nearly knows before he starts just how many hours he is going to get under the rules for such work.

President Pendleton: Does Rule 107 allow for repairs? If the car is under load you get an additional charge for removing the load. At points where I have been we did not consider the additional hour; we took the 24 hours as under Rule 107, but did not count the additional hour for removal of the load.

C. M. Hitch: Our chief interchange inspector and his assistants would undoubtedly have to become familiar with Rule 107 to enable him immediately to issue his transfer orders.

M. W. Halbert: We have had the 24-hour clause in effect in St. Louis and we had no trouble in handling it. If a rule like that were adopted now, all you would have to do would be to familiarize yourselves with the working hours and the cost.

A. Herberster: I do not think the proposition is understood as a whole. If I understand this rightly, any car cannot be transferred, or they will not get paid for the transfer, if the repairs consume 24 man hours or less, according to Rule 107. You cannot necessarily repair a car under the load even though the M. C. B. hours are less than 24; then what are you going to do?

A. Kipp: Suppose that it took 30 hours to repair some car and the next car we repaired in 15 hours; one hand washes the other. If you could save the transfer of a car by getting paid for 24 hours labor and you do not lose more than six hours labor on the job, it seems to me that you are ahead of the game with all of the claims that you may expect when cars are transferred. If the commodity in the car is of any particular value, there are not many instances of transfer but what there is a claim made and I believe the railroads would be ahead if they would put in even more than 30 hours.

On motion, the recommendation of the committee was adopted.

F. H. Hanson: I move that the following change in Rule 2, second paragraph, be recommended:

After the word "defects" in the sixth line, add: "With the exception of cars having defects as enumerated under paragraph F."

The reason for recommending this change is that defects enumerated under paragraph F, Rule 2, tell us what repairs must be made under load. If that car is taken into a yard or shop and is made empty, you can take the same car out

and compel the delivering line to accept the car back with those defects that the rules tell you must be repaired under load. We can see no reason why the defects that can be repaired under load should not be repaired by the handling line when the car is made empty, instead of returning it to the delivery line.

The motion was seconded.

M. E. Fitzgerald: You will have to take into consideration paragraphs I and J of Rule 2 which cover the movement of the car that is properly protected by return when empty card. Assume you run a car to its destination, you may return it if it is properly protected by the return when empty card. I think that the entire paragraph referred to in Rule 2 is out of place. It is properly taken care of in I and J.

The motion was lost.

H. W. L. Porth: Going back to paragraph F, article 3, it seems to me that ought to be changed. I think there are a good many trunk lines that pay no attention to that, even now, but this article was put into the rules at a time when cast steel truck bolsters and cast steel truck sides were an innovation. It is a standard or recommended practice now of the American Railway Association. It seems as if cars traveling under loads with defects to truck sides and truck bolsters should be repaired under loads the same as wheels. I move that it be the sense of this Association that article 3 be changed accordingly.

Chairman Gainey: There seems to be no second.

RULES 4 AND 32.

Mr. Pellien (Asst. C. I. I., Buffalo, N. Y.): Rule 4, second paragraph and Rule 32, last paragraph, carding of slight damage not requiring shopping of car: In order to bring about uniform handling of defect cards for defects of this nature, this rule should be clarified or the wording modified, as at present it does not seem to be interpreted uniformly throughout the country. The word "immediate" should be placed before the word "shopping" and the words "before reloading" should be changed to "except when loaded." This would bring about uniform handling and would very much clarify the rule, making it read as follows:

Defect cards shall not be required for any damage so slight that no repairs are required, nor for raked or cornered sheathing, roof boards, fascia, or bent or cornered end sills, not necessitating the immediate shopping of the car except when loaded, the receiving line to be the judge.

I move that that be accepted.

The motion was seconded.

M. E. Fitzgerald: Could that be construed to mean, if you had an opportunity to move a badly damaged foreign car home to the owner over your line—an intermediary line—that it would prohibit you from moving it to the owner and make you assume responsibility to the owner? You would not be entitled to a defect card unless you shopped the car.

Secretary Elliott: In that case you would card the car before you offered it home to the owner.

M. E. Fitzgerald: I must assume that the owner will shop the car, but many cars are not shopped. The cars are being carded and then reloaded. The rule should be changed but not, in my opinion, in the manner suggested.

Mr. Owen (Peoria, Ill.): The rule is not very plain. At our little point we aim to card everything that we figure has got to be renewed. There is a great difference in the judgment of the inspector whether it has to be shopped, whether it will be shopped when it gets on the home line or whether it will be loaded again. Something definite that would be thoroughly understood by inspectors of small points as well as big interchange points should be incorporated in the rule.

M. E. Fitzgerald: There should be a limit stating specifically a certain payment of damage before the car could

be carded, or there should be a limit placed on the time in which handling lines would be entitled to collect on a card issued. For example, a car is carded in Chicago under load, moving South. The average car is loaded and unloaded in a certain limited time. That has been figured out. At the expiration of that time if the handling lines have not seen fit to repair that defect or found it necessary, the rule has been violated. The car should never have been carded and that card should be made obsolete. The road handling should assume responsibility.

A. S. Sternberg: There would be a bad order card attached to the car signifying that the car must be placed on the repair track. The hardship that rule brings out is something like this: We will say that the C. & N. W. might deliver a car to the C. & E. I. The latter will deliver it home to St. Louis, and will be penalized because the owner puts it in his shop and repairs it. The C. & E. I. is in no way responsible for the damage. The damage was on the car when it came from the Northwestern. I cannot see that the paragraph in itself is so misleading but there is so much difference in the opinion of car inspectors that it would be better if it were out of the rule entirely.

[An abstract of the remainder of the proceedings will appear in the May issue.—EDITOR.]

Relative Effect of Time and Service on Car Deterioration

During 1917 a detailed study of the conditions of rolling stock undergoing repairs was made by a western railroad system to determine the relative importance of "time and elements" and actual service as causes for the deterioration of equipment. The study included both passenger cars and freight cars. It was found that 24 per cent of the expenditure for passenger car repairs and 30 per cent of the expenditure for freight car repairs was made necessary by the effects of "time and elements."

Passenger Cars

In making detailed inspections of passenger cars undergoing repairs, the work was divided into two classes, shop and terminal or running repairs. The shop repairs were studied at the principal coach repair shop on the system by actual inspection of the conditions while the cars were undergoing repairs. A total of 83 cars were inspected while going through the shop.

In gathering data for the running repairs, the work done at two of the principal terminal points on the system, was checked during the period of one month at each place. During the two months the actual number of passenger cars receiving repairs at these two terminals was 4,492.

These two independent studies provided sufficient data from which to determine the average relationship of the various sources of deterioration, so far as each class of work was concerned independently. In order to arrive at a proper classification for all repairs it was necessary to determine the ratio of the total cost of running repairs to the total cost of shop repairs. In order to determine this the total annual cost of shop repairs at the three principal shop points where all heavy repairs to passenger cars are made, was subtracted from the total amount of the passenger car repair account. This determined the expenditure for running repairs. Dividing the total amount thus obtained for each of the two classes of repairs by the average cost per car as determined by the detailed studies, figures were determined representing the number of cars receiving each class of repairs. From these data it was determined that 10,452 cars represented the number receiving running repairs to properly balance the total of 83 cars actually checked while undergoing shop repairs. The two classes of repairs were, therefore, combined

in this ratio to obtain the proper relationship of the various causes of deterioration in their overall effect.

The causes of deterioration are classified as "time and elements," starting, stopping and switching, and running. This applies fully to the draft gears, trucks and air brakes, but for the body no subdivision is made of the effects of actual service. Thus subdividing all repair expenditures, 24.1 per cent is attributed to "time and elements," 41.4 per cent to the effect of service on the car body, 16.4 per cent is due to running and 18.1 per cent to starting, stopping and switching. Of expenditures for terminal repairs alone, 1.5 per cent are due to "time and elements," 51.3 per cent to the effect of service on the car body, 26.2 per cent to the effect of running and 21 per cent to stopping, starting and switching. "Time and elements" accounts for 37.9 per cent of the cost of shop repairs, the effect of service on the car body for 38.2 per cent, running for 8.6 per cent and starting, stopping and switching for 15.3 per cent.

The table shows in detail the relative effect of these sources of deterioration on various parts of the equipment. Grouped by parts of the equipment, it is found that 64.9 per cent of all repair expenditures are for work done on the car body, 27.6 per cent for draft gear and truck repairs and 7.5 per cent for the air brake. Considering terminal and shop repairs separately, the car body receives 51.6 per cent of the terminal repairs, the draft gears and trucks receive 33.6 per cent and the air brake 14.8 per cent while of the shop repairs the body receives 76 per cent, the draft gears and trucks 21.8 per cent and the air brake 2.2 per cent.

PERCENTAGE DISTRIBUTION OF COST OF PASSENGER CAR REPAIRS TO SOURCE OF DETERIORATION

	Terminal repairs	Shop repairs	Weighted totals
Body—			
Inside fittings { Time and elements... .01		6.80	4.20
{ Service 21.60		25.60	21.20
Body proper { Time and elements... .025		31.00	19.30
{ Service 29.70		12.60	20.20
Draft gear and trucks—			
Running 26.2		8.60	16.40
Time and elements 7.44		13.20	11.20
Starting, stopping and switching 7.44			
Air brakes—			
Stopping and switching 13.6		2.10	6.90
Time and elements 1.2		0.10	0.60
	100.00	100.00	100.00

Freight Cars

The sources of deterioration of freight cars were similarly classified as starting, stopping and switching, running, "time and elements," and loading and unloading, the latter applying only to the car body. The data for freight cars were gathered in the same manner as for passenger cars, the work being done at the principal shop and repair track point. A total of 487 cars was inspected in the proportion of one general, three heavy, seven medium and 38 light. The table shows the detailed classification of expenditures on a percentage basis according to the cause of deterioration, still further subdivided as between the car body, the draft gears and the air brakes. Grouped by causes, 45.7 per cent of all expenditures were required because of the effect of stopping, starting and switching, 17.1 per cent was made necessary by the running of the cars, 30.1 per cent by "time and elements" and 7.1 per cent by loading and unloading. Grouped by parts of the car, 59 per cent of the repairs were made to the body, 9.2 per cent to the draft gears, 26.2 per cent to the trucks and 5.2 per cent to the air brakes.

PERCENTAGE DISTRIBUTION OF COST OF FREIGHT CAR REPAIRS TO SOURCES OF DETERIORATION

Body—	
Starting, stopping and switching 16.8	
Running 6.5	
Time and elements 28.6	
Loading and unloading 7.1	
Draft gears—	
Starting, stopping and switching 7.9	
Running 1.2	
Time and elements 0.1	

Trucks—	
Starting, stopping and switching.....	17.5
Running	8.7
Time and elements.....	0.4
Air brakes—	
Stopping and switching.....	3.5
Running	0.7
Time and elements.....	1.0
	100.0

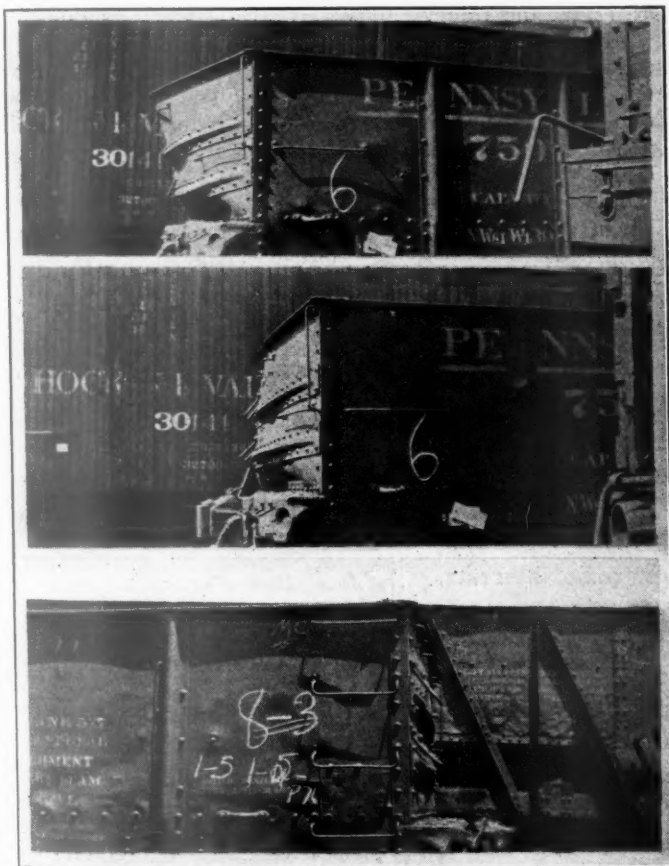
Straightening Car Ends with a Pull Jack

BY A. H. ANDERSON

It is not generally realized that pull jacks furnish a simple and effective means of straightening steel ends without removing them from the car. Where the ends are bulged out so that they interfere with the end clearance or the efficient operation of the brake staff, particularly on cars which have the staff passing through an outside end sill, it is a simple matter to straighten them. This device can also be used

together, the end is forced back into place. The timber can be reset from time to time on different points until the ends are entirely straightened.

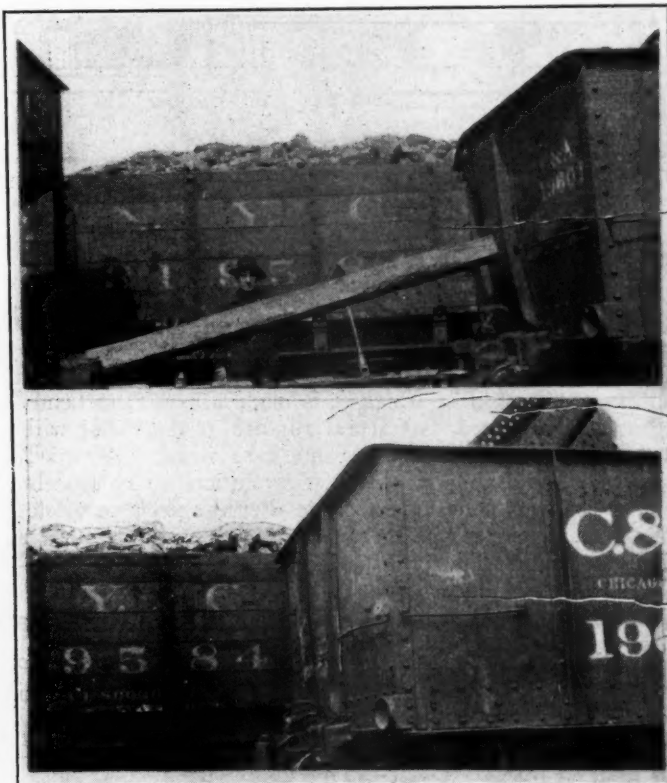
Only two men are required for this class of work. By using a $\frac{5}{8}$ -in. chain about 10 ft. long with grab hooks on both ends, it is usually possible to avoid pinching cars together and the same length timber can be used for various jobs. This method is especially useful for repairing steel



Pull Jacks Facilitate Handling Jobs Such As This

for jacking in and fastening the ends on any class of car with wood or composite ends, whether loaded or empty. It is also applicable for trimming loads that are shifted over the end of the car and many other items that are taken care of on the repair tracks.

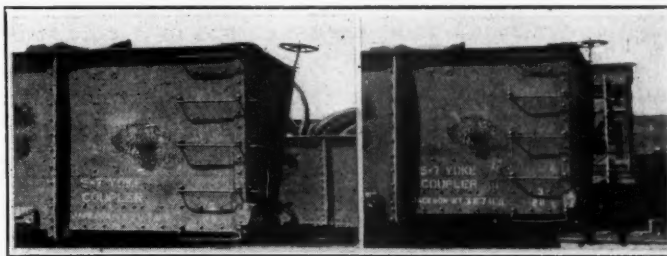
All that is needed for this class of work is a pull jack of ten tons capacity or even lighter. It is convenient to have two jacks for use when a long push is desired. In using the jacks, the knuckles are removed from the couplers on each car and the hooks of the pull jacks are placed around the knuckle pin. An oak timber of good quality, about 6 in. by 6 in., is used for pushing the end of the car, one end of the timber being placed against the bulged end as near the center as possible, or on the end brace if there is one, while the other end rests against the end sill of the other car. If the second car is loaded, the timber may be placed directly against the end. By drawing the pull jacks



A Loaded Gondola Car Straightened Without Shifting the Lading

ends at small repair points where there are no facilities for cutting down the parts and riveting them in place again.

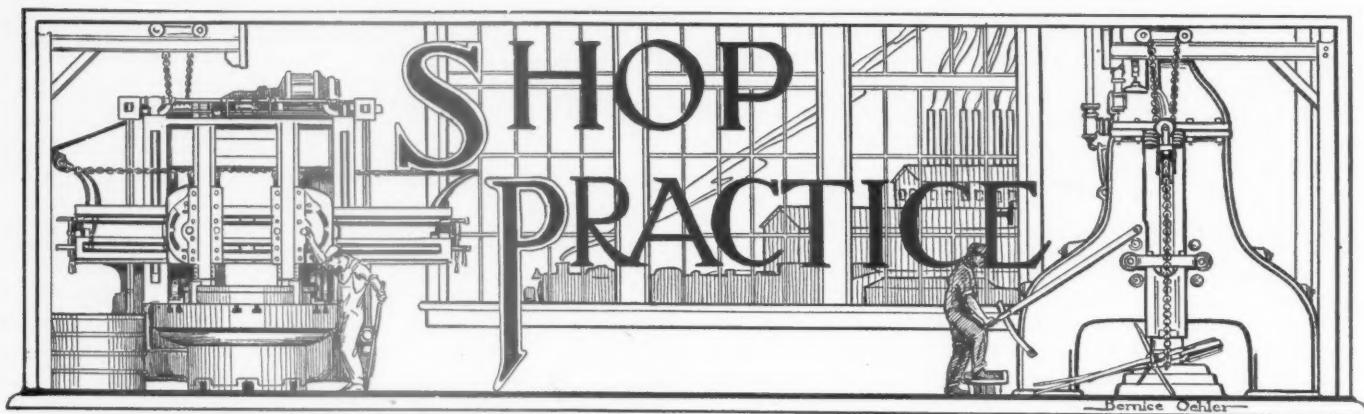
A few typical jobs done with this equipment are shown in the illustrations. The car in Fig. 1 was loaded with steel bars, 30 ft. long, to within 18 in. of the top. The lading was against the end of the car. By the use of the pull jack, the end was straightened to the position shown in the second view, when it was necessary to shift the load with an



A Bulged End Repaired by Two Men in 20 Minutes

engine. The third view shows the end completely straightened after shifting the load. The total time required for this job was six hours for two men.

The second car shown carried a load of tank heads, 10 ft. in diameter, which were resting against the end. As shown, the end was bulged out 1 ft. at the top. The lading was pushed back as the end was straightened and all work on the car was completed by two men in 30 minutes. The third illustration shows another typical job of straightening, this being completed by two men in only 20 minutes.



Progressive Failure or Fatigue of Metals Under Repeated Stress*

BY H. F. MOORE†

If a freight car axle is subjected to a heavy overload, the ductility of the steel of which it is made allows it to bend. The axle is distorted, but actual rupture of the metal will not take place. Consider now the case when the loaded freight car is running. For every revolution of the wheels there is on every longitudinal fibre of the axle a complete reversal from tension, pulling action, to compression, crushing action. If failure occurs after the car has run many thousand miles, the action is entirely different from the bending action under a single heavy overload. Almost without warning the car axle snaps short off, and the steel behaves as if it were a brittle material rather than a ductile material. Such sudden failure under repeated loading is said to be due to the fatigue of metals, and occasionally occurs in shafting, automobile parts, airplane parts, wire ropes, band-saws, steam and gas engine parts, and other parts of rapidly moving machinery.

Explanations of Fatigue Failures

The apparent change in the nature of metal which fails under repeated stress gave rise to the theory that under repeated stress some profound change took place in the very nature of metal, changing ductile to brittle metal. This change was spoken of as crystallization, and it was supposed that under repeated stress, metal changed its structure from fibrous to crystalline, and as evidence the sharp crystal appearance in the fracture under repeated stress was brought forward.

In the latter years of the last century, various metallurgists began to use the microscope as a means of studying the internal structure of metals, and their work, especially that of the English metallurgists Ewing, Rosenhain and Hum-

frey, showed that the structure of metals is always crystalline either before or after repeated applications of load. They showed that the fracture under repeated stress was due to the spread of minute cracks, called by them slip lines, which extended completely through the crystals of the metal and which, spreading and uniting into large cracks, acted similar to minute hacksaw cuts, gradually reducing the cross section of a machine part until it could no longer carry its load and suddenly snapped off, very much as a piece of iron falls off when cut almost in two by a power hacksaw.

The starting point for one of these minute slip lines may

well be some point in the metal where a minute flaw exists, either in the shape of a flaw within the metal, or in the shape of a notch or sharp scratch on the surface. We think commonly that our mathematical formulas for figuring the strength of machine parts are exact, because they involve exact mathematical processes; as a matter of fact these formulas neglect thousands of minute actions which tend to destroy material. For example, they take no account of a cutting action where a shaft rests on the edge of a bearing. Under a single load, these minute actions are of no importance; their effect is so localized that no appreciable effect is produced on the deflection of a piece. If, however, the loading is repeated thousands or millions of times, then such a microscopic cutting action may start a crack, which under repeated stress

will spread to causing final failure.

Any sharp discontinuity in metal, due either to a surface defect or to an internal flaw, greatly increases the stress in the metal over a microscopic area around it. This fact has been verified both by experiment and by mathematical analysis. As an example, it may be cited that the localized stress at the edge of a rivet hole may be as high as three times an average internal stress in the metal of a plate; the stress near the bottom of a sharp notch may be five or six times as high as a stress a few hundredths of an inch away from the notch. At the danger of wearisome repetition it seems worth while again to emphasize that these localized stresses are of negligible account for structural and machine parts subjected to few loadings, but may be of the greatest importance

The Foreman and His Outlook

You are working for a large organization. You have jurisdiction over one comparatively small section of one of the several departments of that organization.

What do you know about your road—its extent, its policies, its financial condition, its operating problems, its traffic interests, its relations to the public, etc., etc.?

You say these things do not concern you! Are you sure of this? How can you co-operate intelligently with other departments if you know so little about the railroad as a whole?

Your department is not isolated; it is not an end in itself. It is one small member of the greater body all of whose parts must work in harmony and unison if effective work is to be done.

*A paper prepared under the auspices of the Engineering Foundation, the National Research Council, the General Electric Company, Schenectady, N. Y., and the University of Illinois Engineering Experiment Station, Champaign, Ill.

†Professor of engineering materials, University of Illinois, Champaign, Ill., and in charge of joint investigation of fatigue of metals.

in the case of parts subjected to many thousands of loadings.

The problem of the designer and the metallurgist is to determine limiting conditions so that this progressive failure will not occur. The usual method is to make sure that no fiber in any part of a machine member is loaded beyond the elastic limit of the material by any load which will come upon it. The difficulty of applying this rule is twofold. In the first place, the determination of the true elastic limit of metal is a matter of a great deal of uncertainty. Delicate methods of measurement of stretch and careful methods of computation give an elastic limit lower, sometimes much lower than the value given by the ordinary commercial test. Some doubt exists as to whether actual material is perfectly elastic under any stress, no matter how small that stress is. Here again it should be noted that a slight inelastic action is of no account for a structure loaded but a few times. But under load repeated many thousands of times any damage due to slight inelastic action is cumulative and actually may cause final failure. In the second place it practically is impossible to figure all the small localized stresses in a machine member, especially in an irregularly shaped machine member. Sharp shoulders or notches may cause localized stresses many times those which would be given by the ordinary formulas of mechanics.

This progressive spread of small cracks is offered as an explanation of the occasional failure of springs while under the action of light loads. At some time in its history a spring is subjected to a few heavy loads. These heavy loads start microscopic cracks and are not repeated often enough to cause them to spread far. However, these microscopic cracks are in themselves very sharp notches, and cause high localized stress under subsequent light loads with consequent spreading of the cracks and final failure. For a machine part subjected to repeated stress it may be necessary to know its history as well as the properties of the material in order to judge of its safety.

Machine for Making Fatigue Tests

At the present time the most satisfactory method to determine the ability of material to resist repeated stress is to make actual tests of it under a great many repetitions. Over a year ago the joint investigation of fatigue of metals was organized by the National Research Council under the auspices of the Engineering Foundation, University of Illinois Experiment Station, and National Research Council and was given as its main problem, the study of the behavior of a number of common kinds of steel under repeated stress. Tests are carried for several specimens of each kind of steel to one hundred million complete reversals of stress.

The machine used for the greater part of the testing is, in principle, a car axle placed upside down. A circular specimen rotates in bearings and is driven by a motor; weights are hung on it at two symmetrical points along its length. The bearings used are all ball bearing so that friction is reduced to a minimum. The suspended weights set up bending in the specimen; compression along the top side of the specimen and tension along the bottom. When the specimen rotates 180 degrees, any given longitudinal fiber changes from compression to tension, a complete reversal of stress. A revolution counter gives the number of cycles of stress. The machine runs at 1,500 revolutions per minute and operates day and night. A battery of 15 such machines now is in operation. In testing any kind of steel or other metal, tests are made on such a machine, using various weights. In this manner the number of reversals required to cause rupture is noted. It is found that there seems to be a fairly sharp limit of stress below which failure does not occur at one hundred million repetitions. Moreover, a curve plotted with stress as ordinates and numbers of repetitions for failure abscissas seems to be horizontal for this limiting stress. This stress is called the endurance limit of the metal, and is con-

sidered an index of the ability of the metal to resist repeated stress.

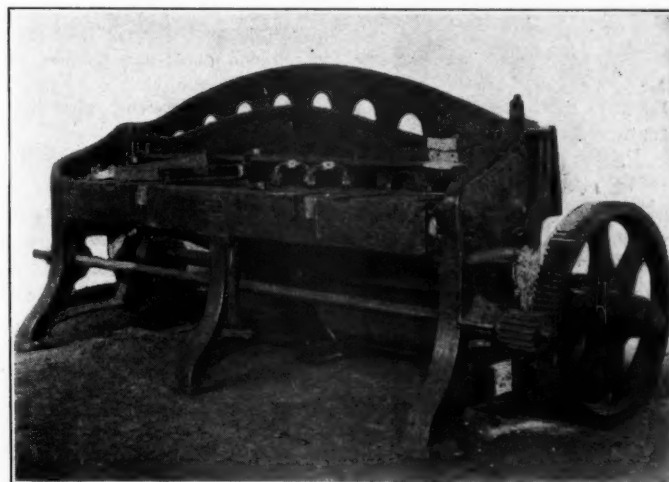
Factors in Fatigue Resisting Strength of Metals

The quantitative statement of factors affecting the fatigue resisting strength of a metal cannot be given at this time, but certain qualitative indications may be noted. Those fatigue resisting strength of metal depends upon: (1) Its elastic strength; (2) its ductility; (3) probably the amount of initial stress left in it by heat treatment; and (4) its homogeneity of structure. Possibly still other factors enter. It is evident that high elastic strength would tend to increase the fatigue resisting qualities of a metal. The effect of ductility may be explained by the fact that at a small flaw in a piece of ductile material some stretching would be found with a consequent tendency to distribute the stress over more material than in the case of a brittle material. Initial stress would, of course, tend to start microflaws when a slight additional working stress was given. It might be noted that if an ordinary testing machine test is made of a piece of steel containing initial stress, the measurement of stretch would be taken over a considerable length of the specimen and there would be a tendency for the positive and negative initial stresses present at different parts of the cross section to neutralize each other and thus to mask the first point of yielding of the specimen. This neutralizing tendency would not, however, prevent any initial stress from starting a crack when it was reinforced by a slight additional working stress. Inhomogeneity of a material is a source of weakness under repeated stress in that it permits the stresses to break down, because of the already started microflaws.

Probably many cases of fatigue failure of machine parts are blamed on the material used, when they should have been blamed on the shape of the piece or on the surface finish. In conclusion, it is desired again to call attention to the great danger of starting microflaws at the root of sharp shoulders, notches, or rough tool marks on a piece. Good surface finish and generous fillets at shoulders are vitally necessary in a design of parts to be subjected to repeated stress.

Wrecked Shear Reclaimed by Oxy-Acetylene Welding

The \$3,000 metal shear shown in the illustration was broken in thirteen different places. In common parlance it



Heavy Shear Repaired by Welding

was a "total wreck," and not many years ago would have been worthless except for a nominal value as scrap. In this day of modern welding, however, broken machinery of all

A Locomotive Repair Shop Scheduling System

Foremen Are Relieved of Details and Shop Output Is Increased
by Applying the Locomotive Schedule in Railroad Shops

BY GRANT GIBSON

LACK of progress in systematizing work in railroad repair shops is often due to failure on the part of mechanical department supervisors from gang foremen to superintendents of motive power to appreciate records and shop schedule systems. This is a rather pointed statement, but nevertheless true. The lack of appreciation of the man trained to keep records is ever present among railroad men and until such time as shop supervisors recognize the value

the average railroad may have fifteen or twenty types of locomotives.

The shop man should realize the similarity in organization referred to which is plainly shown in Fig. 1. The dissimilarity lies in the fact that the manufacturing plant has a production clerk to route and follow up the work while in most cases the railroads use their general foremen for this purpose. Put a production man under each general foreman—a man who will follow the work through—and the general, shop and gang foremen will have a great deal more time to plan department work and install improved methods.

An editorial entitled, "Systematizing Management in Railroad Shops," which appears in the November issue of the *Railway Mechanical Engineer*, incorporates three important factors in shop output:

1. Time Study.
2. Cost Records and Accounting.
3. Shop Scheduling and Follow-Up System.

The time study and cost records are really secondary in importance to the third factor, shop schedule and follow-up system, and it is the object of the writer to describe briefly in this article a method that will systematize railroad repair work, relieve the foremen of details and provide considerable increases in shop output.

Simplicity must be the keynote as any system involving an army of clerks is top-heavy and liable to break under its own weight. While there is a decided lack of system in the handling of repairs to passenger and freight cars, it is not as apparent as with locomotives, therefore, this article will be confined to the scheduling of locomotive repairs.

Duties and Records of Engine Clerk

The engine clerk of the superintendent of motive power is the chief dispatcher of locomotive repairs. His duties are to maintain all locomotive records including mileage, assignment, cost of maintenance, etc. The mileage is reported to him by the general superintendent of transportation; the cost of repairs by the shop superintendent or master mechanic.

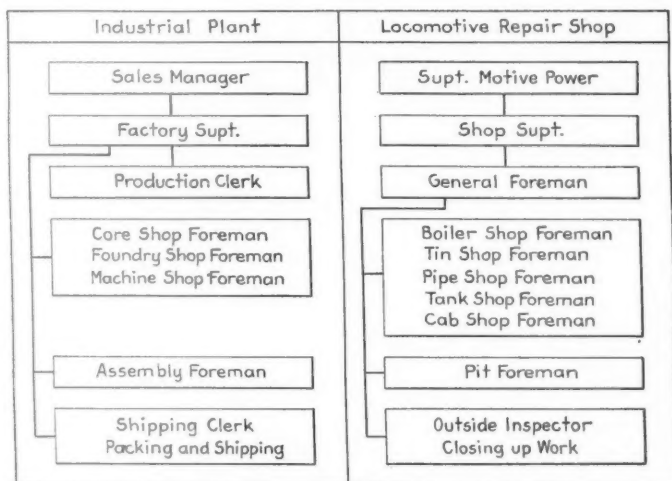


Fig. 1—Chart Showing Comparative Organizations. The Parallel Is Not Complete Until a Production Clerk Is Added Under the General Foreman

of records in marking progress, warning of past mistakes and indicating possible future improvements, one avenue of increased shop output will remain closed.

One of the thoughts that first came to the writer upon undertaking industrial work (after fifteen years in railroad mechanical departments) was the similarity of railroad and industrial organizations and four years as superintendent of a manufacturing plant has served to make this thought

Engine Number										FORM 1								
Division to which Assigned	Shop	Class of Repairs	Cost	Date In	Date Out	Total Miles	Month	Locomotive Mileage By Divisions										
								Division #1	Division #2	Division #3	Division #4	Division #5	Division #6	Division #7	Division #8	Division #9		
							19__											
							Jan.											
							Feb.											
							Mar.											

Form 1, Showing Mileage and Locomotive Repair Data

sink deeper. There is absolutely no reason why the same systems that have increased the efficiency of manufacturing plants should not provide greater railroad repair shop output. The contention that "due to the diversity of railroad work" these systems cannot be installed is prejudiced error; they can and will eventually be installed. What railroad shop has a wider diversity of work than exists in the plants of the International Harvester Company for example? This company repairs and builds a thousand types of machines;

Form 1 is suggested for the purpose of maintaining this record. Incorporated therein are all the essentials, the left side of the form reflecting repairs and the right the miles made on the various divisions. One card is provided for each locomotive and is made to cover a three-year period.

It is poor policy to wait for a locomotive to go to pieces before repairing it and the practice should be to schedule the repairs according to mileage except in the case of wrecks. In applying the new system, the superintendent of motive

power should first take into consideration the condition of power, right-of-way, past performance of the locomotives in passenger, freight, switch and work train service, arbitrarily

Form 2.

1920.

Mr. _____
Shop Sup't.,
Master Mechanic _____

Dear Sir:

According to my records, Engine _____ is due for { heavy repairs _____ 1920. This locomotive has made _____ miles since last heavy repairs and _____ miles since last light repairs. You will find attached hereto, for your guidance Form 3, describing in detail these repairs.

You will arrange for immediate inspection of this locomotive, to determine what repairs are necessary. Give your storekeeper a list of material needed in order that he may have same on hand when engine is held. (If engine is to be sent to another shop for repairs forward this information to the Master Mechanic or Shop Sup't in charge in order that he may have an opportunity to get his material together.)

This engine is to be repaired in _____ Shop and upon completion of repairs, Form 3 should be sent me giving in detail all repairs made and the cost.

Yours truly,

Supt. Motive Power.

Mr. _____
General Foreman.

Dear Sir:

Please note the above and with return of this communication filled out in every detail please send me Form 5.

You may retain Form 3 for your guidance.

Yours truly,

Shop Sup't.—Master Mechanic.

Form 2 is Sent Out by the Engine Clerk

to segregate in the storehouse the materials needed for repairs. It would be ideal if the stores department could carry sufficient stock at all times to protect itself, but this is impracticable from a financial standpoint. Assume that two months is required for this segregation of material. Two and one-half months before an engine is due for repairs, the engine clerk sends out Form 2.

The time for sending out Form 2 is readily determined by subtracting from the maximum desired locomotive mileage between shoppings, two and one-half times the average monthly mileage. Form 2 is two-fold, the upper half being directed to the shop superintendent or master mechanic and the lower half to the general foreman. Form 2 is accompanied by Form No. 3, "Details of Repairs," which will be explained later.

Upon receipt of Form 2 at the shop the figures shown thereon are transferred to the upper parts of six forms, 4a, b, c, d, e, and f, covering detailed work in the boiler, machine, blacksmith, tin, pipe and tender shops respectively. Partial Form 4a, as illustrated for the boiler shop, is typical of the others.

To allow for carbon copies, two each of Forms 4 are turned over to the roundhouse engine inspectors (boiler and machinery) who fill in the column "Report of Engine Inspector," after they have looked over the locomotive. They will report the repairs or replacements which develop under their observation and this information is a guide to the shop foreman who subsequently makes a more thorough examination. After the engine inspectors complete their report, the

Details Of Repairs To Locomotive _____				At _____				FORM 3.			
Part	O New x Rep'd	No. Pieces	Remarks	Part	O New x Rep'd	No. Pieces	Remarks				
ENGINE FRAME				RODS							
Frame Right				Main Rod Brass R.or L. For B							
Frame Left				Main Rod Strap R.or L. For B							
Front Deck				Side Rod Front R. or L.							
Brasses				Retaining Rings or Segments							
Cellars				Axle (kind of material)							

Form 3 of Which a Part is Here Illustrated, Includes Additional Details Under the Heads Engine Truck, Driving Wheels, Trailing Wheels, Tank, Tender, Frame and Truck, Cab and Pilot, Air Brake, Air Signal, Painting, Steam Chest, Cylinders, Valve Gear, Power Reverse Gear, Pistons, Boiler, Firebox, Smokebox, Grates, Staybolts, Flues, Superheater, Steam Pipes, Brass Work and Miscellaneous

Locomotive_____										
Repaired At_____				Date In_____		Date Out_____		Class of Repairs_____		
Department	Estimate			Actual			Over		Under	
	Labor	Material	Total	Labor	Material	Total				
Machine Shop										
Boiler Shop										
Blacksmith Shop										
Tin Shop										
Tender Shop										
Cab Shop										
Total										
General Overhead										
Grand Total										

MONEYS EXPENDED DUE TO ACCIDENT:-

Labor		
Material		
Total		
Grand Overhead		
Grand Total		

Cause of Over-run:-

setting up a maximum mileage between repairs for these classes, as for example:

Passenger locomotives, 120,000 miles.
Freight locomotives, 85,000 miles.
Switch locomotives, 65,000 miles.
Work-train locomotives, 70,000 miles.

The next step is to determine the length of time required

Summary Appearing on the Back of Form 3

forms are returned to the general foreman, who gives them to his respective department heads. The general foreman also arranges with the roundhouse foreman to hold the engine for a thorough inspection, this being two and one-half months before the shopping is due. The roundhouse foreman knocks out the fire at the first opportunity and advises the several foremen when they may inspect.

The shop foremen (with engine inspectors if necessary) make an examination and very carefully fill in the several columns on Forms 4 under the heading "Foreman's Report."

Extreme care should be exercised by foremen in filling in

the "Foreman's Report" as it is through this medium that the production clerk gets his line-up for scheduling. If, for example, the boiler shop foreman shows on the form that the front tube sheet merely needs repairs and subsequently it is discovered that a new sheet is needed, considerable delay will be incurred if there is no material on hand with which to make up the sheet.

Estimated and Actual Repair Costs

It will be noted that two columns are provided on Form 4a covering "Estimated Cost of Repairs" and "Actual Cost of Repairs." The sole idea in having the foreman fill in the first is to actually commit him as to the probable cost. If he declares the work will cost \$8,000, he will make an effort to come within that amount. The production clerk will procure from the accounting department the actual cost of repairs after their completion and the discrepancies should be called to the foreman's attention by the general foreman. Each foreman, upon completion of his report, will sign in the

Again drawing a comparison between the industrial and railroad fields: the superintendent of motive power is the customer who orders engine number so-and-so in for repairs. Figuratively speaking, he pays for these repairs as his success is measured by his cost of maintenance per locomotive mile.

Second, the shop superintendent or master mechanic is the manufacturer and he is in the same position as an industrial manager. If the price, delivery and quality of work turned out by a manufacturer is not up to requirements, the purchasing agent will not give this manufacturer another order, but will let out the business to a competitor. If the cost, quality and speed of locomotive repair work done under the direction of a master mechanic or shop superintendent is not up to the expectations of the superintendent of motive power, the business will be switched, not to another concern, but to another man.

Third, there is the gap in the railroad line-up, as illustrated in Fig. 1, where the general foreman is the production clerk. By creating an additional position at a nominal

Mr. _____ FOREMAN Dear Sir:- Engine No. _____ which has made _____ miles since last heavy repairs, is due for _____ CLASS OF REPAIRS repairs _____ 192____. This engine will be placed on pit number _____ At your earliest opportunity you will examine this locomotive and fill in the form below in all details. The Engine Inspectors report is shown thereon. For your guidance you will find attached hereto, Form 1 covering last heavy and light repairs. Where no repairs are necessary you will mark O.K. <div style="text-align: right;">Yours Truly _____ GENERAL FOREMAN</div>										FORM 4a		
		Report of Engine Inspector		Foreman's Report								
				Material Necessary				Mat'l On Hand	Mat'l Not On Hand	Estimated Cost of Repairs		Actual Cost of Repairs
Rep's	New	Rep's	New							Labor	Material	Labor	Material
BOILER AND PARTS:-												
Boiler												
First Ring												
Second Ring												
Third Ring												
Side Sheet Right, Outside												
Flues												
Combination Tubes												
Brick Arch												
Brick Arch Tubes												
Misc :-												
Total												
General Foreman:- I estimate it will cost \$ _____ to perform the above work. I can complete this work in _____ days. <div style="text-align: right;">_____ FOREMAN</div>												

Form 4a is Made to Include All Details of Repairs to Boilers and Parts and is Typical of Forms 4b, c, d, e, and f, Covering the Other Shop Departments.

space below and return one copy to the general foreman, retaining one for his file.

Forms 4 provide the information called for on Form 5 which is forwarded to the shop superintendent or master mechanic, who in turn forwards it to the superintendent of motive power. Forms 4 are given by the general foreman to the production clerk.

Duties of the Production Clerk

A first-class production clerk saves his salary many times over each year by keeping the stock of finished parts at a minimum. He must not have an excess of any materials on hand; he cannot guess at his stock; he must *know* and his only method of knowing is through the medium of records. The production clerk in the industrial field is not a man of the trades; he is a clerk and must be a brainy one at that.

salary, the general foreman can be relieved of a hundred small, annoying details that come up daily in the locomotive repair shop. Instead of worrying over these infinitesimal things, he can concentrate on the big things.

It has been stated before that the engine clerk in the superintendent of motive power's office instituted Form 2 two and one-half months before the locomotive was due to be shopped. It has probably taken ten days or two weeks to collect information required on Forms 4 and 5; therefore two months are left in which to prepare for the repairs.

The first thing to do is to arrange for the necessary material. Form 6, which is self-explanatory, is filled in by the production clerk and forwarded to the storekeeper after being approved by the general foreman.

It is the duty of the storekeeper to check his stock immediately and if he finds certain items missing, to order them at

to be retained by the production clerk and two to be forwarded to the superintendent of motive power.

An Appeal for the Shop Schedule

The foregoing incorporates the fundamentals of a shop schedule system, which will assist throughout the entire department. Don't let the bugaboo "diversity of work" deter you from endeavoring to institute some of the big ideas that have placed manufacturing companies years ahead of railroads in efficiency. Don't throttle your general foreman by making him follow up the short ends in his department. Give him a production clerk to dispatch his work and keep the main line open. Don't wait until the management on your railroad decides to install some high class efficiency system which often proves too cumbersome. Beat them to it by developing a simple shop schedule in charge of a live schedule man or production clerk. See that every one co-operates and watch results.

Welding Locomotive Cylinders

BY C. E. FARLEY

General Locomotive Foreman, Horton Shops, Chicago, Rock Island & Pacific

It is a well-known fact that badly broken cylinders are being welded in many railroad shops throughout the country at the present time with gratifying success. Figs. 1 and 2 show the repair of an unusual break in the right cylinder on a Mikado type locomotive. The entire front end of this

was left open to allow the welding of the dividing wall between the exhaust and admission ports. The usual method of preheating was used, building a brick furnace enclosing the entire cylinder, using charcoal for preheating. The fire was started at 12 o'clock midnight, and the welding started at 7.30 A. M. Using two torches when possible, 16 blow-pipe hours were required to complete the job.

The cylinder, welded and ready for the boring bar, is shown in Fig. 2. It will be noted that only one bushing was removed from the valve chamber, the cylinder bushing and the back chamber bushing being left in place. The valve chamber was bored in the front end for reapplying the bushing, the front joints on both valve chamber and cylinder being faced. It was not necessary even to bore the cylinder. All that was required on the by-pass valve chamber was to ream the seat as it lined up perfectly with the back end chamber.

A great deal was saved by not having to remove the bushing, as is the general practice where a heavy job of welding is to be performed. The operation, as described, has been proved practicable by a number of other cylinders that were welded without removing the bushing and are giving good service. The total cost of the welding was approximately \$300 for labor and material, making a saving of not less than \$700 on the entire job.

The opposite cylinder on this same engine was welded, as shown in Fig. 3, the flange that holds the cylinder to the frame being entirely broken off. The cylinder was removed, turned up at an angle of 90 deg., and the flange welded in place, as illustrated. It will be observed that the cylinder

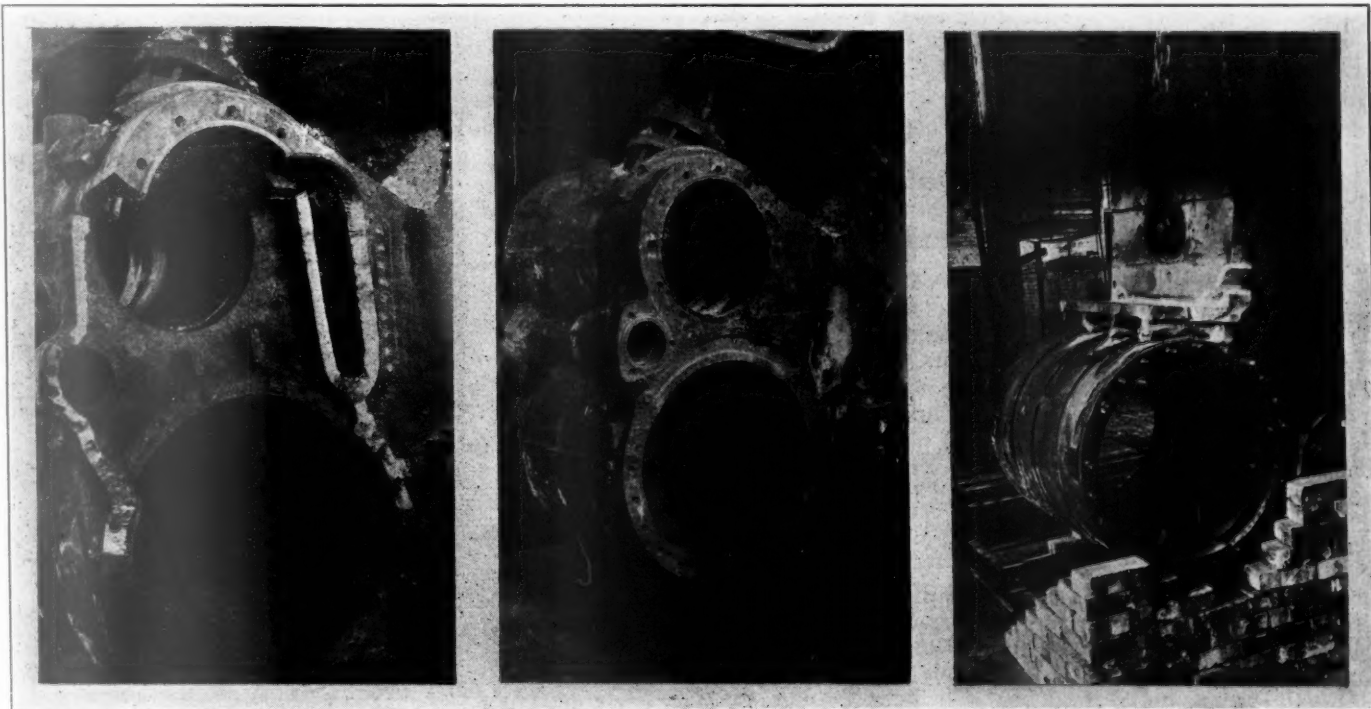


Fig. 1

Fig. 2

Fig. 3

Examples of Difficult Locomotive Cylinder Welding

cylinder was gone, including the division between the steam chest and cylinder. The cylinder had been patched previously, but when a piston head flew off, carrying with it the front cylinder flange, these patches were damaged. Their removal was also necessary in order to get at the broken parts conveniently for welding.

The entire casting was prepared and welded to the cylinder wall all in one piece (previously built up in the welding shop) except the outer wall of the steam chest, which

is supported by a chain, and the broken flange, which rests on top, must be welded at the back and the four bridges. The cylinder was reapplied to the engine, all splice bolts being saved and used over again, thus making the cost of this job very reasonable. In all, the two jobs of cylinder welding on this engine cost less than one cylinder in the rough. The welding operations were performed by a local machinist welder, assisted by representatives of the Oxweld Railroad Service Company.

Application of Shoe and Wedge Liners to Driving Boxes

On almost no question regarding the proper maintenance of locomotives has there been a wider diversity of opinion than regarding the best method of compensating for wear in the driving box shoe and wedgeways. Liners have been applied and held in place by short countersunk head brass screws. In some cases brass liners have been cast in place being held by means of diagonal undercut grooves. Under the severe hammering which driving boxes receive in service, however, liners applied by these methods tend to work loose and require frequent renewal.

To overcome this difficulty, many railroads have adopted the practice of tack-welding steel shoe and wedge liners in place and have thereby greatly reduced the number of liners working loose. Even in applying plates by welding, a con-



Driving Box Shoe and Wedge Liner Tack-Welded in Place

siderable divergence of practice has been found, but the method illustrated has shown good results.

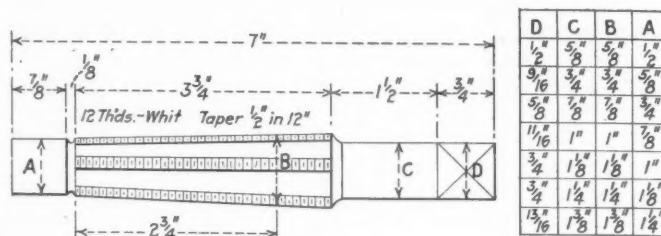
These shoe and wedge liners are made of steel and beveled on the edges by planing, a number of liners being held at the proper angle in a planer chuck and planed at the same time. The liners are welded to the driving box shoe and wedge ways at the edges and, to assist in holding the liners, six holes are punched in them for tack welding as shown.

Tapping Radial Holes in Boiler Shells

The difficulty which inexperienced workmen find in tapping holes in boiler shells so that studs applied in these holes will be on radial lines, is well known. For example, most air compressor brackets are supported on the barrel of the boiler by means of six studs. The brackets range from 2 to 3 ft. long and the studs are about that distance apart. If tapped into the boiler on radial lines the studs will not be parallel, but many times an attempt is made to have them parallel and the result is undue strain on the stud to say nothing of an unworkmanlike looking job.

In order to overcome this condition and facilitate the application of boiler studs along radial lines, the tap illustrated has been devised. The end of the tap is extended as shown at A in a cylindrical surface equal in diameter to the smallest diameter of the thread. With care in drilling

the boiler shell on a radial line (the diameter of the hole being slightly larger than A) the tap will obviously start in the direction of the drilled hole and, as a result, the hole will be tapped along a radial line. The proportions of A, B, C, and D are shown in the table for seven different



Tap Developed for Tapping Radial Holes

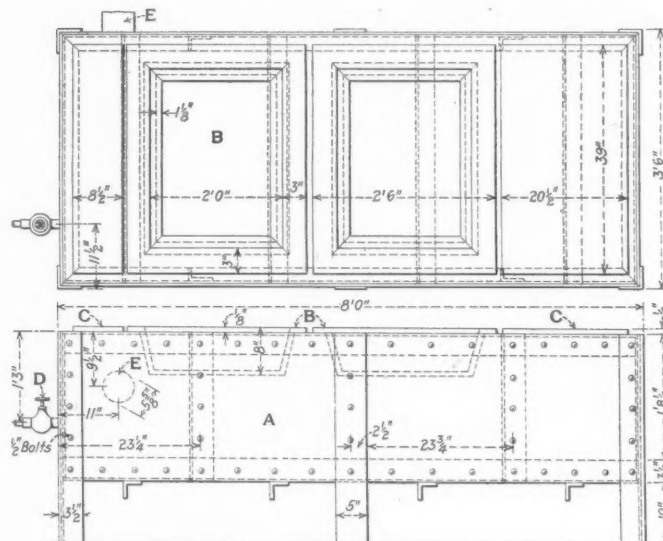
sizes of taps. The use of this tap will also aid in tapping a hole at right angles to a given plain surface, following the direction of the drilled hole as previously described.

An Easily Made Babbitting Furnace

BY E. A. MILLER

For babbitting driving boxes, crossheads and other miscellaneous locomotive parts, the babbitting furnace shown has given exceptionally good service. The furnace A is supported by four 1/2 in. by 3 1/2 in. by 3 1/2 in. angle irons and 1/2 in. by 5 in. plates centrally located on each side. The furnace is made of 5/16 in. sheet iron, both sides and ends being stiffened all around by 5/16 in. by 3 1/2 in. plates riveted to all the vertical supports. The side sheets and bottom are stiffened by four 5/16 in. by 3 in. angles. There is also a reinforcing angle iron all around the top which supports two cast iron babbitt containing pans B and two cast iron plates C.

The bottom and sides of the furnace are lined with 3 in.



Babbitting Furnace of Simple Design

fire bricks covered with fire clay. A burner D for crude oil is provided; also a vent E. The cast iron pans are 1 1/8 in. thick and 6 7/8 in. deep inside. Removing one or both of the cast iron plates C will tend to cool off the furnace as desired, and they can also be used to preheat certain parts, such as rod brasses, etc. This furnace has given satisfactory service and a number similar in construction are now in use.

Making a Drill Live Up to Its Reputation

Satisfactory Results in the Use of Twist Drills Can
Be Secured in One Way Only—by Correct Grinding

BY H. WILLS

The Standard Tool Company, Cleveland, Ohio

WHEN considering the almost human mechanical appliances employed in making standard types of twist drills and the precautions taken in the various operations from the laboratory tests of the steel bars to the final inspection, it is a fairly safe conjecture that if a drill gives trouble, some of the conditions surrounding its use are not right.

Twist drills will stand more strain in proportion to their size than almost any other tool and a large percentage of drill troubles could be eliminated with proper attention given to grinding the points. The form of the drill point controls the rate of production, accuracy of the hole, frequency of necessary grinding and the life of the drill. In fact, the most carefully made drill can be spoiled by poor grinding.

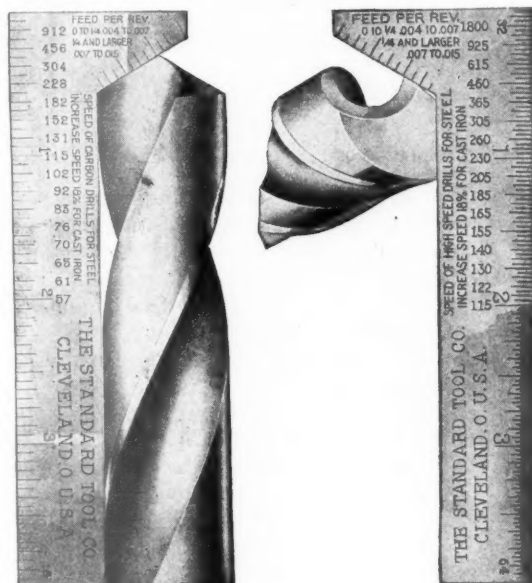
In testing a drill to determine whether or not it is properly

$\frac{1}{8}$ -in. mark is a number showing the proper speed at which to run a drill of corresponding diameter.

Correct and Incorrect Grinding

Both cutting lips must be inclined at the same angle with the axis of the drill and must be of equal length. The point angle of 59 deg. (Fig. 1) has been universally adopted as best suited for average conditions. The drill point must have the proper clearance or contour of surface back of the cutting edges and this clearance must be identical on both sides. Approximately a 12 deg. clearance angle (Fig. 2), combined with the center angle of 130 deg. which will give a constantly increasing clearance toward the center, has proved best for average conditions.

Some of the undesirable conditions resulting from drill points improperly ground are illustrated. If both lips are not ground at the same angle with the axis (Fig. 3), one lip will fail to counteract the tendency of the other to spring away from the cut; consequently, one lip will do more work than the other, which will result in its becoming dull more



Measuring Length and Angle
of Cutting Lip

Estimating Approximate
Center Angle

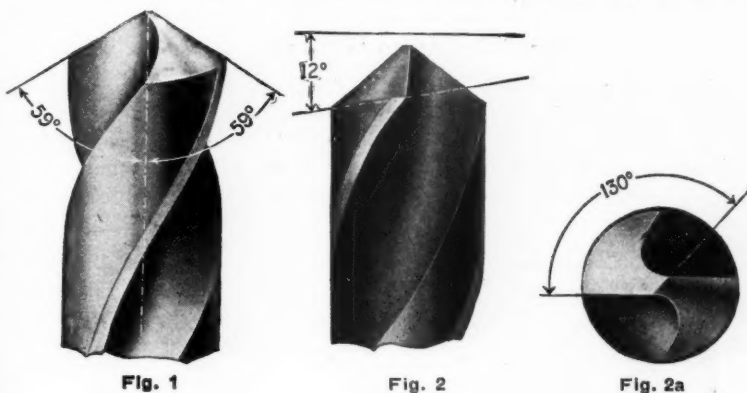


Fig. 1

Fig. 2

Fig. 2a

rapidly than if both lips were cutting equally. In addition, it will be subjected to an abnormal torsional strain.

When the cutting lips of a drill have the same point angle, but are of different lengths (Fig. 4), the point of the drill will be "off center" or eccentric. As a result, the hole will be oversized to an extent equal to double the amount of this eccentricity. If the drill point is ground with both lips at different angles and of different lengths (Fig. 6), there will

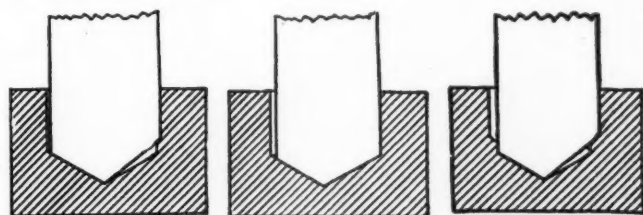


Fig. 3

Fig. 4

Fig. 5

be a combination of the undesirable results described in the last two paragraphs.

The side and end views of a drill with the proper point angle (59 deg.) and the proper angle of clearance at the

ground, the first requirement is some form of twist drill grinding gage chart and scale, as illustrated. Two methods of holding the scale while measuring the length and angle of the cutting lip, also when estimating the approximate center angle, are shown. Although the included angle of the gage is only 118 deg., a close estimate on the recommended center angle of 130 deg. can be made.

Twist drills must be properly ground and run at the correct speeds and feeds in order to do their work efficiently and with the aid of the gage illustrated, any skilled workmen can obtain these best results in increased drilling production. The gage is ground to an angle of 118 deg. and is graduated in thirty-seconds and sixty-fourths on one side and sixteenths on the other. The gage indicates the proper angle and length of lip to which the drills should be ground. It also shows the speeds and feeds recommended for drilling steel and cast iron, one side when carbon steel drills are used and the other when high speed drills are used. Opposite each

periphery (12 deg.), but with insufficient clearance at the point or center, are shown in Fig. 6.

A drill with insufficient clearance both at the periphery and at the center is illustrated in Fig. 8. The line *ABC* is at an angle of 12 deg., but there is no clearance immediately back of the cutting edges *BC* and the excess of clearance at the heel *AB* is of no benefit. The common result of grinding a drill with insufficient clearance is plainly shown in Fig. 8, and this splitting is almost sure to follow any attempt to obtain maximum production.

A drill with the proper clearance angle of 12 deg. is shown in Fig. 9, but it does not have the proper contour back of the cutting edges. This manner of grinding leaves the cutting edges thin and weak, causing them to crumble away under heavy speeds.

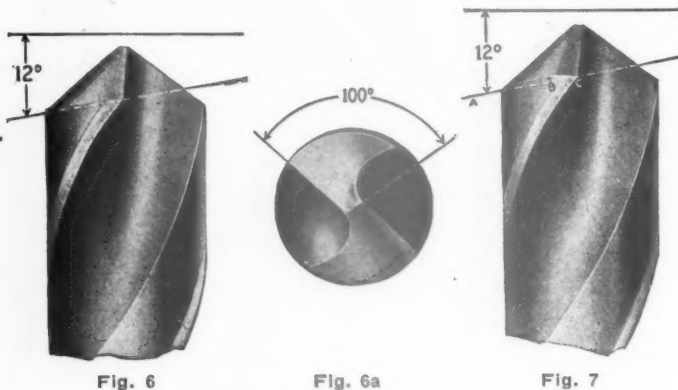
Maintaining Standard Web Thickness

Most twist drills are made with a gradual increase in the thickness of the web or center of the drill toward the shank. As the drill becomes shorter and the web thicker, greater force is required to drive it. To overcome this condition, it is good practice to thin the web to the original dimensions. This grinding must not extend too far up the flute of the drill and care must be exercised that the cutting lips are not injured; also that the same amount is ground out of each groove. Fig. 10 shows a drill with the web properly thinned. In Fig. 11, the grinding is excessive, leaving the web entirely too thin and liable to crumble. When this happens, a split drill is practically inevitable.

Incorrect grinding is usually the cause of drills splitting up the center, and no manufacturer should be called upon to replace a split drill, unless a flaw is evident in the steel.

General Precautions to Observe

Twist drills are made with a slight taper from point to shank, so that the largest diameter is always across the corners of the cutting lips. This prevents the drills from binding in the work, when they are sharp. If the outer corners are allowed to become badly worn, the drills will bind



and cannot perform satisfactorily. Whenever the outer corners of the cutting lips show wear, the drills should be re-ground and every particle of worn surface removed, or the drills will continue to bind and very quickly be damaged beyond repair.

In grinding high speed drills, care should be taken not to overheat them, and when heated they should never be plunged into cold water. Doing so is likely to cause small surface cracks which reduce the efficiency of the drill and may result in serious damage to it. Forcing the grinding on a wet grinder may also bring about the same condition.

If the suggestions for grinding drill points contained herein are followed and drills are run at the proper speeds and feeds, satisfactory results are practically assured. It is, however, hardly possible to do this grinding as accurately

by hand as by using a good twist drill grinding machine, of which there are several on the market, and their use is earnestly recommended.

Broken or damaged tangs of drills are generally the result of an imperfect fit of the drill shank in its socket, which may be caused by a worn-out socket, dirt or chips accumulating in the socket, or bruises on the shank of the drill. In either case the driving power of the taper is reduced or destroyed, resulting in an abnormal strain being put upon the tang.

A drill of either carbon or high speed steel that can be filed is not necessarily too soft for service; in fact, if drills were tempered so that a good file would make no impression, they would be entirely too hard for general use. Any doubt regard-



Fig. 8



Fig. 9

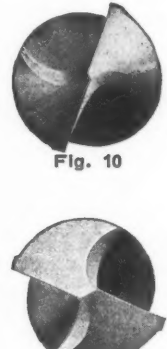


Fig. 10

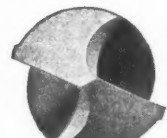


Fig. 11

ing the temper can be checked by trying the drills in actual service.

Speeds and Feeds

There are so many conditions affecting drilling operations that it is extremely difficult to establish hard and fast rules for speeds and feeds. Published tables can be safely followed when drilling in commercial materials and experience will enable the operator to determine what changes, if any, can be made from them. Assuming that a drill is properly ground, when the corners of the cutting lips wear away rapidly, it is an indication that the speed is too great. If the cutting edges roughen or break out in minute particles it indicates that the feed is too great. A word of caution will not be amiss regarding the use of very small drills. It is seldom that these are run at more than a fraction of the speed necessary to obtain the best results, and excessive breakage is inevitable. These small drills are delicate tools; be sure they run true and that the cutting edges are kept sharp. A fine grade emery stone is best suited for this purpose.

Driving Box Chuck

BY E. A. MILLER

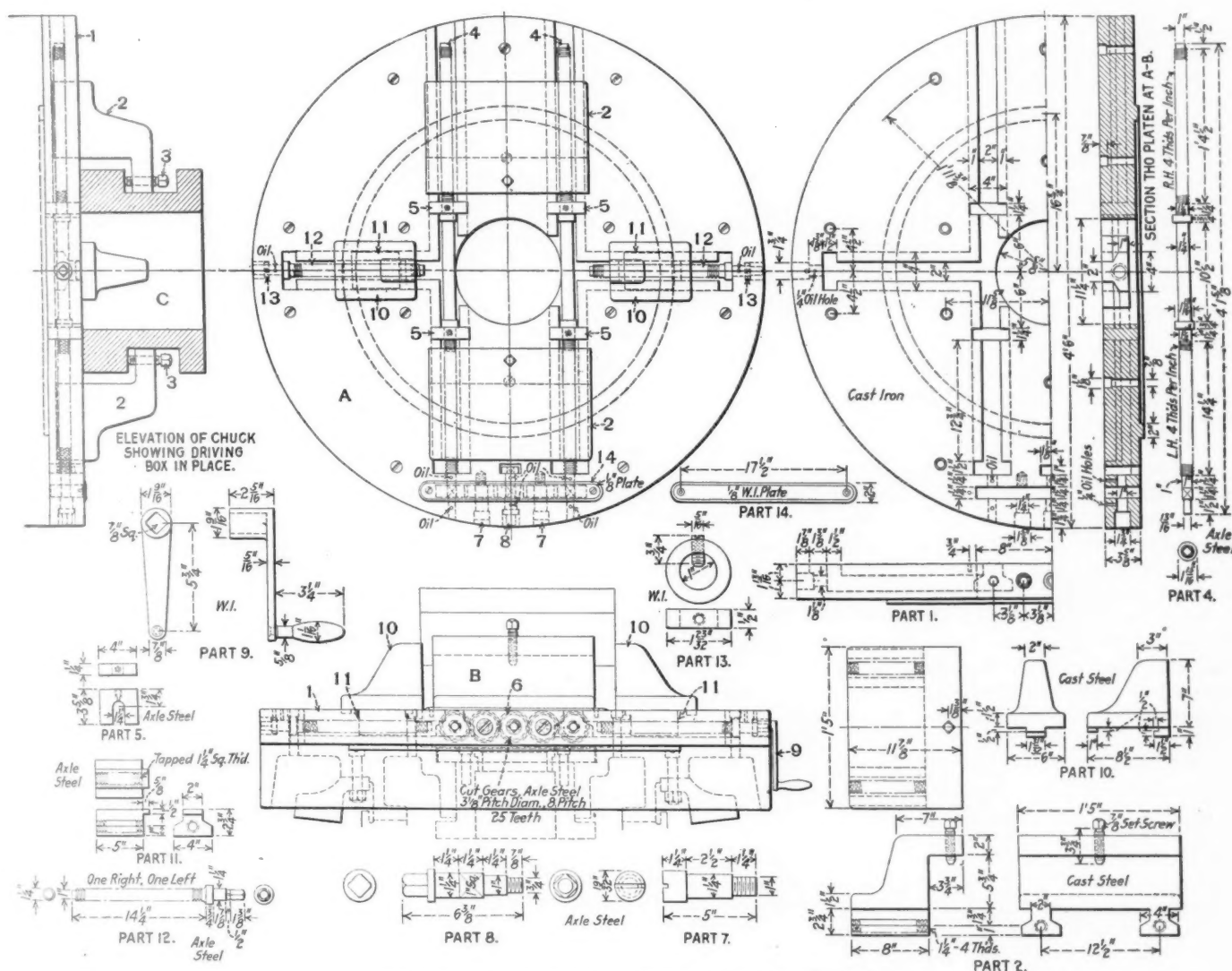
A driving box has been developed, as shown in the illustration, for application to 54 in. boring mills, and its use will result in a considerable saving in the time ordinarily required to set up driving boxes preliminary to the operation of boring crown brasses. Referring to the illustration, *A*, *B* and *C* are the plan, front and side elevations of the assembled driving box chuck. Details of the individual chuck parts also are shown, and will aid in a full understanding of the operation of the chuck.

The base plate *1* is made of cast iron $3\frac{5}{8}$ in. thick and provided on the under side with a ring which fits in a corresponding groove in the boring mill table. The chuck is secured to the table by means of fifteen $\frac{7}{8}$ -in. bolts, with round, slotted heads flush with the top surface. The base of

the plate 1 is slotted, as shown in the detailed view, to receive the working parts of the chuck. Two large jaws 2, which are provided to center the driving box, work together, one being drilled and tapped with four right-hand square threads per inch, the other jaw being tapped with four left-hand square threads per inch. Two long screws 4, provided with right and left-hand threads are arranged to screw into the movable jaw 2. Any rotation of the screws, therefore, causes the jaws to move together or apart depending upon the direction of rotation.

Care must be taken in assembling to see that the long screws are started in the jaws at the same time so the jaws will centralize. Four axle steel pieces 5 are arranged to fit corresponding slots in the base and by contact with shoulders

The small jaws 10, like the larger ones, are of cast steel but are not tapped out for the $1\frac{1}{4}$ in. square threads (four threads per inch). Two additional parts 11 are arranged to fit grooves in the platen and threaded to receive the $1\frac{1}{4}$ in. short screws 12. The detailed views of parts 10 and 11 will indicate how they fit together and how turning one of the short screws will cause movement of the small jaw in or out, depending upon the direction of rotation. The two parts 11 are tapped, one with a right, and the other with a left-hand thread. These parts and the short screws have to be assembled before the long screws and main jaws are put in place. Two collars 13 are provided for application to the short screws after they are in place and prevent their longitudinal movement. A set screw in each



Driving Box Chuck as Applied to 54-In. Boring Mill

on the long screws as shown, prevent longitudinal movement of the screws. Five eight-pitch gears with 25 teeth each are arranged in a train as shown. The middle and outside gears are provided with square holes for application to the long screws and the operating pin 8; the other two gears are idlers mounted on pins 7. Pins 7 are provided with 1 in. threads on the ends and make into corresponding tapped holes in the platen. Pin 8 is held in place by a $\frac{3}{4}$ in. nut on the end and a cotter to prevent it from working off. It is evident that, through the train of gears, the turning of pin 8 by means of handle 9 will turn the long screws in the same direction and move the jaws 2 together or apart as may be desired. Movement of the jaws is simultaneous.

collar provides for its adjustment on the short screw and for tightening in the desired position. A gear guard 14 is provided to cover the five gears and keep them free from chips. The $11\frac{1}{4}$ in. hole in the center of the platen allows all chips to drop through and prevents interference with the boring bar. Oil holes are provided throughout to lubricate moving parts. As an additional precaution to insure accurate work, two set screws 3 are provided in the large jaws 2. Tightening these set screws after the centering jaws have closed against the driving box, will hold the box firmly to the platen and prevent any tendency to tip up on one side. For the rapid, accurate machining of driving boxes this chuck has demonstrated its value.

Curing Troublesome Frame Failures

BY FRANK ROBERTS

In going over the records for the past four years, it was found that 205 broken frames had been welded at the principal repair shop of a road having about 350 locomotives. Attention was especially attracted to the number of failures at the foot of the pedestals, shown at A, Fig. 1. By actual count there were 86 cases where the break was at one pedestal; seven cases where two pedestals were broken on the same locomotive and one case where three were broken on one locomotive. Altogether 103 pedestals were welded. All the rest of the frames broken in various places totaled 102. It has been found that 50 per cent of our frame failures occur at the pedestal foot.

This proves conclusively that the design of this part of the

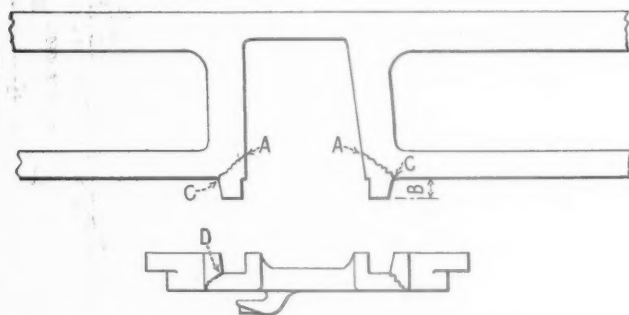


Fig. 1—Sketch Showing Location of Frame and Binder Failures

frame should be changed and it is a simple matter to increase the section sufficiently to insure against such failures. Fig. 1 shows the location of typical failures. There is usually so little difference between dimension B and the depth of the binder slot that the binder comes up very close to the frame, making it necessary to cut a fairly sharp corner at C. A sharp corner is always a weak point and dimension B should be made $\frac{1}{2}$ in. or $\frac{3}{4}$ in. longer to leave a good protecting fillet at C.

As a measure of increased strength the foot should be carried back along the frame about two inches further as shown in Fig. 2. This alteration will strengthen the pedestal foot and eliminate breaking at this point. Any man familiar with shop or enginehouse troubles is fully aware of the

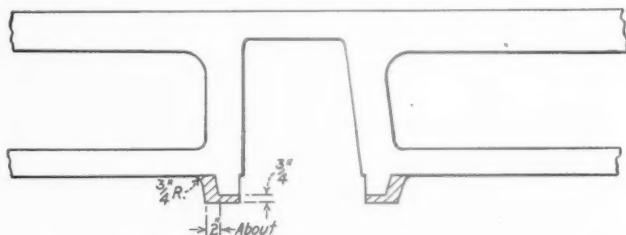


Fig. 2—Proposed Method of Strengthening Pedestal Foot

extent and expense of the above failures and the engineering department will at once appreciate the reasons for making the change as well as the effectiveness of the proposed change in design.

Considerable trouble has been experienced also through the failure of pedestal binders. The breakage occurred at point D in Fig. 1 and the design of the binder was changed, making a $\frac{1}{4}$ -in. fillet at the bottom of the opening, thereby stopping the trouble. The whole fit of the binder on the pedestal had to be redesigned for the new pedestal, making arrangement for a good fit with no bearing on the fillets.

It is desirable to so design locomotive frames that the weakest link will be the part that can be most easily re-

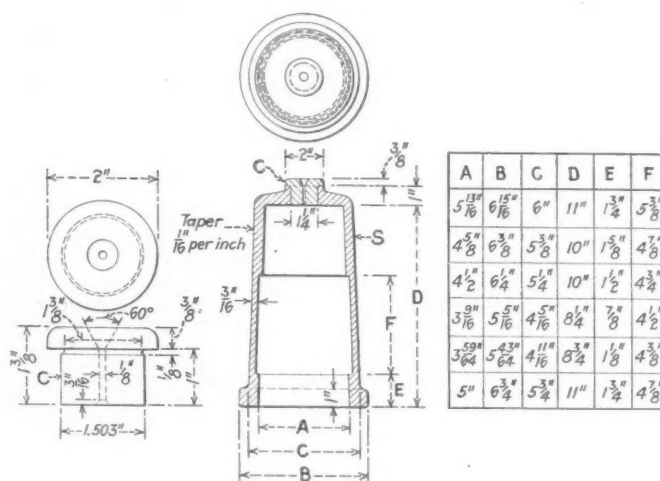
paired. Certainly the pedestal foot is a hard part to repair and if breakage must take place, it is much better to have it in the binder than in the frame. The present improvement in strengthening the frame should place the advantage on the side of the frame.

Piston Rod Centering Sleeve

BY E. A. MILLER

If often happens that the end of a piston rod becomes battered in disconnecting the crosshead and in some cases the center is so badly damaged that it is exceedingly difficult to true the piston rod in the lathe or grinding machine. To overcome this difficulty, a special centering sleeve has been devised as shown in the illustration.

The sleeve S is made of axle steel, being reamed to the standard gage for the tapered piston rod end. Dimensions are shown for six different sizes of centering sleeves, arranged to fit practically all classes of piston rods received for repairs. It will be noted that the inside taper fit of the sleeve is relieved for at least half of the fit and this allows easy



Centering Sleeve for Piston Rods with Damaged Centers

application or removal of the sleeve without impairing its accuracy. The outside of the sleeve S is tapered $\frac{1}{16}$ in. per inch. A tool center C is made to the shape and dimensions shown, being hardened all over and ground, with an allowance of .003 in. for the shrink fit in the sleeve.

The application of this centering sleeve gives the same results as the original center in the piston rod, and will be found to save a large amount of time in truing up piston rods with damaged centers.

Hardening Hammer Die Blocks*

BY R. B. KERR

Since the introduction of the modern drop forging hammer, the problem of producing and successfully heat treating large dies to get the maximum of service with a minimum of loss, has engaged the attention of steelmakers and steel treaters alike.

Early in the game it was found that the percentage of loss from hardening from various causes was heavy. Flaws or pipes in the interior of the blocks resulting from improper casting or forging; steel of too high or irregular a carbon content; and more especially inadequate tempering room equipment, are among the chief causes of failure. The un-

*Abstract of a paper presented by title by R. B. Kerr, foreman, heat treating department, John Deere Harvester Works, East Moline, Ill., before the Philadelphia convention of the American Society for Steel Treating.

fortunate hardener too often is made the goat for the sins, mostly of omission, of both the steelmaker and the shop foreman.

Directions for Heating

While die blocks can be heated successfully in either coke or oil furnaces or even in the smith's forge, a gas heated furnace of the oven type is by far the most convenient and satisfactory for this work. Coke makes a nice clear fire of fairly simple regulation, and with a skillful heater in charge, good results can be obtained. An objection to its use is the frequent presence of impurities, particularly sulphur.

When heating dies the considerable air pressure required to burn fuel oil, makes necessary the most extreme care to prevent scaling or surface decarburization in the parts to be treated. The furnace, therefore, should be of the muffle type, the heating chamber completely inclosed, or if this is not available, the die should for protection be packed face down in a gas tight box of suitable size half filled with charcoal, and the whole thing heated up.

It might be said in passing that this method of pack hardening is excellent for heating dies and tools of nearly all descriptions. The parts come out of the packing box uniformly heated with a surface perfectly free from scale and in the best possible condition for hardening. The process is an old and successful way of heating steel and deserves to be more widely known and practiced.

Whatever the type of furnace used or the means employed the all important thing is to get a good heat on the die (a thorough slow soaking, uniform heat) for upon that depends to a great extent the success or failure of the operation. Particularly for the benefit of the younger steel treaters it may be said that thorough careful heating, more especially when handling comparatively large blocks of steel, is most essential.

For heating, a gas-fired, oven furnace of ample capacity should be used as being most convenient and suitable for the job. If the oven is already hot so much the better, if not, it should be brought up pretty well before putting in the work. Dies of any description should not be put into a cold furnace. Nothing is gained in time, and besides some chances of surface decarburization are offered with a too rapid increase in temperature.

Place the die in the furnace face down, unless the nature of the impressions makes this impossible, in which event it is good practice to protect the surface from possible gases by laying a closely fitting piece of asbestos or sheet steel on top while heating. As another precaution, if the die is of considerable size and the impressions are deep or irregular, it is well to bring it up to a dull red heat, about 1300 deg. F., and let it partly cool off in the furnace before taking the hardening heat.

Heat slowly and regularly. The time required will vary in proportion to the heating area of the furnace and the size and shape of the piece to be treated. Usually three to five hours are required for drop forging dies of average size. The most important point is to get a uniform heat throughout the piece, and one of the most valuable assets a steel treater can have is the ability to judge or sense correctly when a large block of steel is heated properly throughout. The average grade of hammer die steel will harden nicely at around 1450 deg. F. and the heat always should be held stationary for at least 15 minutes before removing the die from the fire. This insures a uniform temperature throughout the entire die.

Quenching and Drawing

The quenching tank should be of ample size and the water supply arranged so that it can be forced upward against the face of the die with considerable force and volume, using an overflow pipe of sufficient size to take it away. In most cases

clean fresh water is all that is necessary, but if extreme hardness is required or if the water is soft or muddy, the addition of a little salt will sharpen it. Place a resting rack across the top of the tank, arranged at a sufficient depth so that the impressions on the face of the die will be well covered with water when the die is laid on it. On flat surfaced dies or on dies in which the impressions are shallow, a depth of from 1 to 1½ in. is about right.

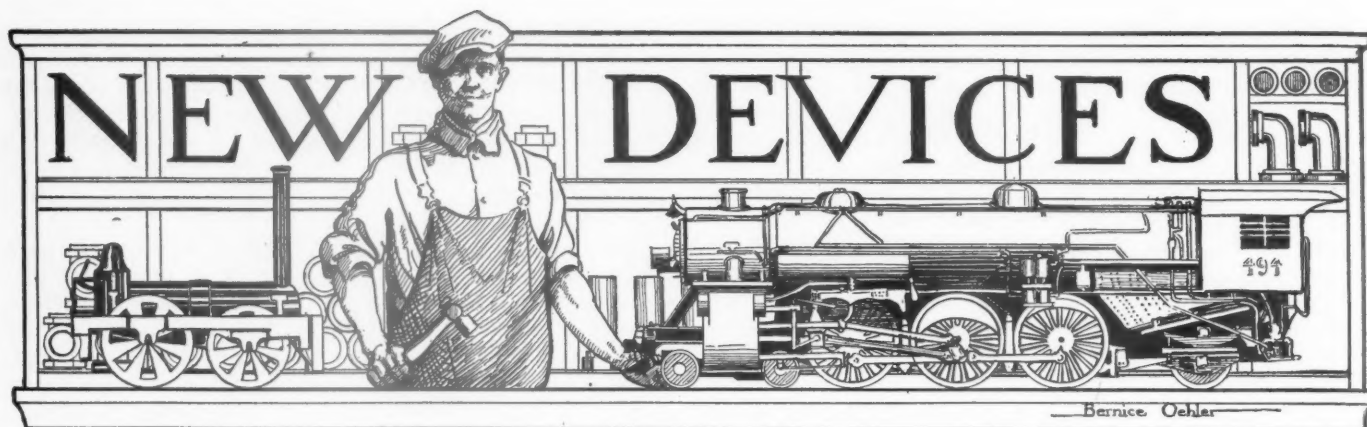
When all is ready get the piece out of the fire. If there are any dangerous looking corners or sharp projections that do not need to be hard, partly cool them off with a water jet or piece of water soaked waste to prevent chipping. Place the die on the resting rack face down and turn on the water. If the piece is wide or flat, prevent warping or crowning by keeping the back slightly cooled off; just enough water and no more. Run the hand over the face frequently to find how it is cooling off.

The temper should be drawn slightly on all hammer dies, both to relieve strains and to give them resiliency or spring, as well as for better wearing qualities, and the drawing should be begun immediately, even before the die is quite cooled off. If there is an oil tempering furnace at hand large enough, get the piece into it. Raise the temperature to around 400 deg. F., and hold it there for an hour or so. If for any reason this method cannot be used, swab the die with light machine oil and place it in a furnace partly cooled off. Leave it there until the oil begins to flash, then remove and allow it to cool off in the air.

Danger Due to Internal Friction

A die should never cool off entirely in the water. When a mass of steel at the hardening temperature is plunged into cold water, the grains in its outer surface immediately become set and rigid. A certain amount of contraction and shrinkage also takes place, partly because of the change from high to low temperature, and also because of the hardening of the metal. The amount of this shrinkage is in exact proportion to the surface area of the mass being treated; the greater the area the more the shrinkage. If this change took place all the way through there would be no trouble; but it does not. In the first place the interior of the piece cools off much more slowly than the outside, and, secondly, the setting of the grains, due to hardening, extends in a depth of from only ¼ to ½ in. at the most. This suddenly chilled outer layer is consequently being forced against the softer mass inside with an enormous pressure, causing distortion and strains which become more marked as the piece cools off. When the temperature recedes to a certain stage, governed partly by the temperature of the quenching water and the air, a violent action takes place. This is the danger point. The friction created by the molecules striving to adjust themselves to the new conditions generates heat inside. Heat means expansion, and unless this condition is offset promptly by heat applied to the outside to relieve the strains, the die, particularly if a large one, has about an even chance of bursting open. Whether it does or does not, the strains are there and are just as liable to manifest themselves in service later on with possibly more serious effects than if they appear immediately after hardening.

Allowing the dies to remain in the water too long and failure to draw the temper promptly after hardening is responsible for considerable breakage. This is partly due to the lack of proper equipment, and also to the fact that the principles involved are not so generally understood as they might be even among steel hardeners. This heat generation by friction, or as some might call it, molecular reaction inside of a body of steel, is no pet theory, but the author has noted its effects during many years of close observation and practice in the heat treating of steel, and believes it will be found in line with the natural laws governing cooling bodies.



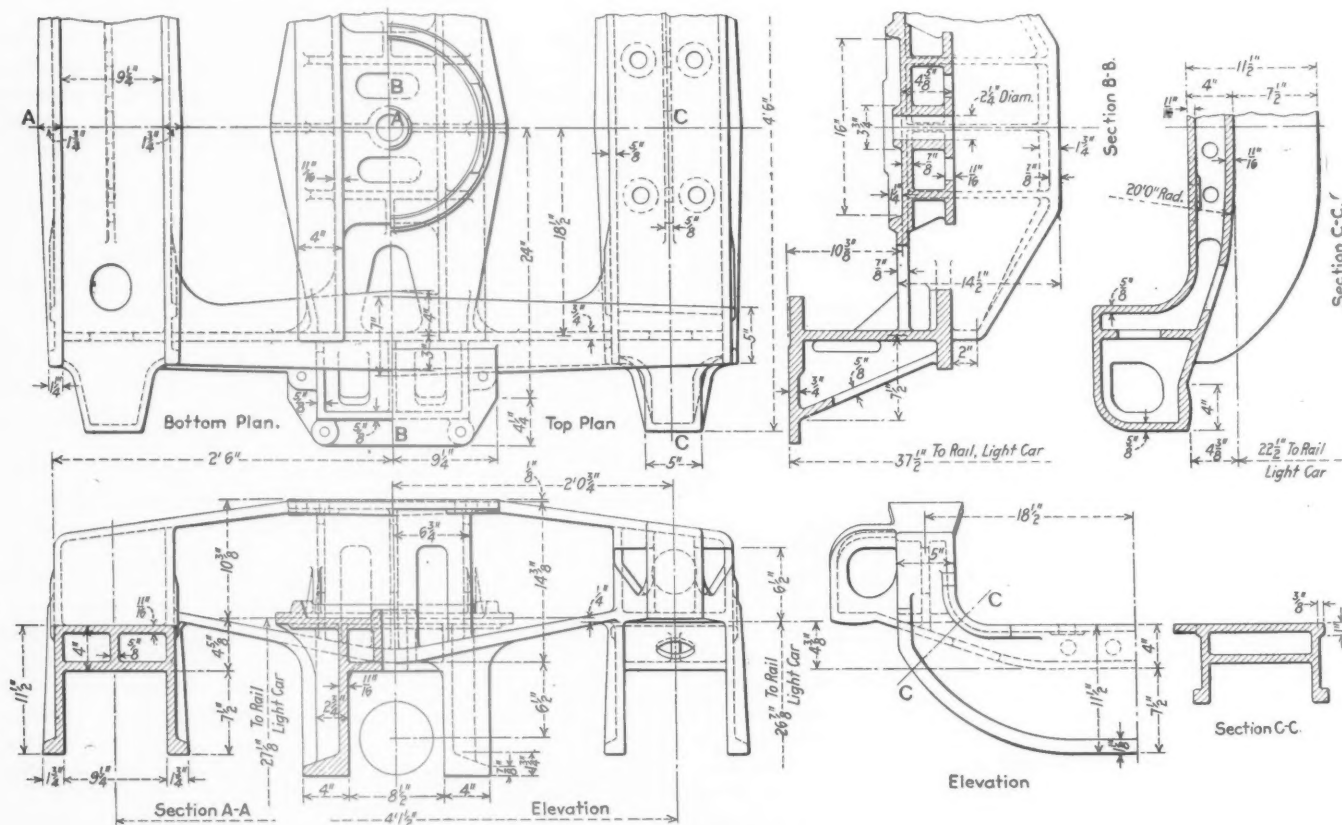
Lamont Six-Wheel Truck for Freight Cars

A NUMBER of designs of equalizing six-wheel trucks have been developed for freight cars varying in capacity from 90 tons to 120 tons. The Lamont truck, the most recently developed of this type, has been brought out by the American Steel Foundries, Chicago, and has received its first installation under several of the new 120-ton coal cars built for the Virginian.

This truck differs from other six-wheel trucks for freight

The springs are placed directly over the journal boxes and coil springs are used throughout.

The bolster consists of three parts: two cross bolsters and one equalizing bolster. The ends of the cross bolsters rest on the equalizing levers, and the equalizing bolster, which carries the center plate and truck side bearings, bears at the center of the cross bolsters with a clearance of $\frac{1}{4}$ in. at the side bearings when the car is riding level. The con-



Details of the Equalizing Bolster

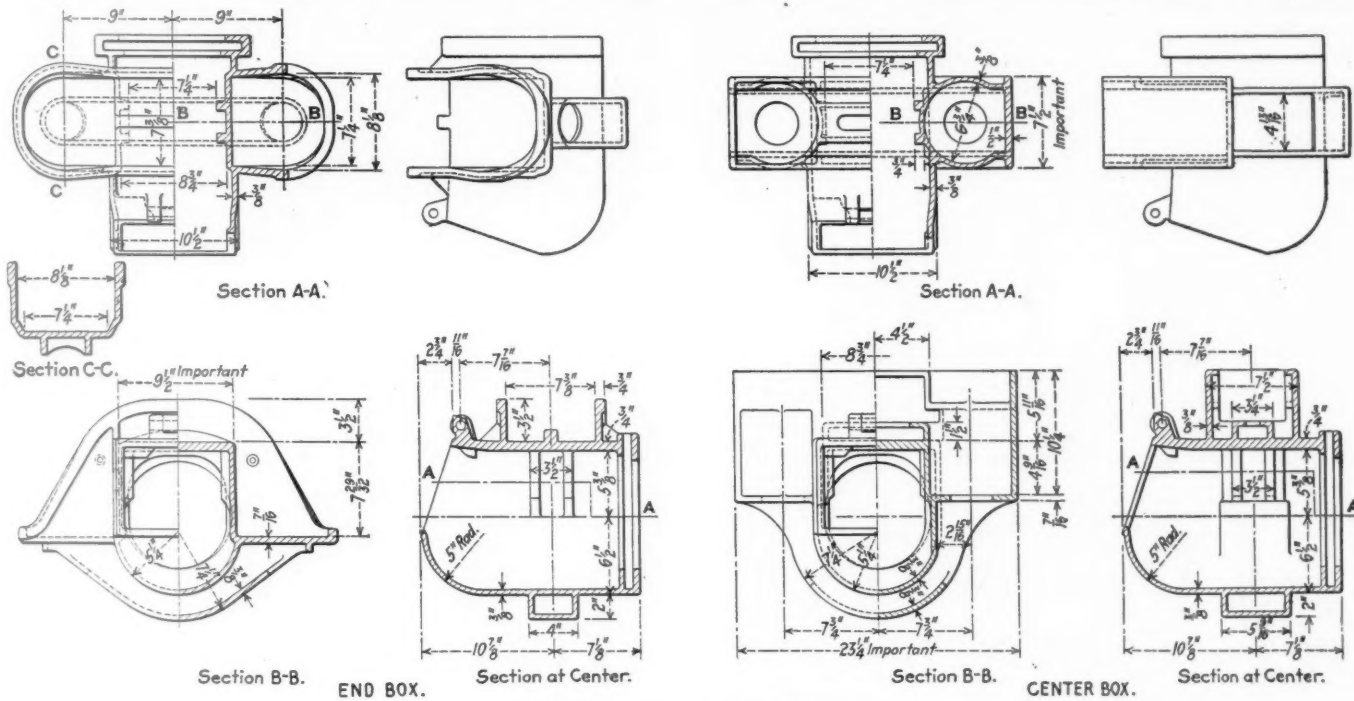
cars in bolster construction, the method of equalizing and the arrangement of the springs. The feature of the bolster design is its three-part construction, which provides for cross equalization of the load distribution to the four points of delivery to the longitudinal equalizing mechanism. The equalizing mechanism permits a symmetrical location of the bolster ends between the wheels, thus making possible a short wheel base and a simple arrangement of the brake rigging.

The construction of the equalizing bolster is shown in one of the drawings, from which it will be seen that the center plate load is delivered to the side members of the equalizing bolster and through these to end portions which, taken separately, are inverted U-shaped bolsters designed to bear at the center of the cross bolster and nominally take one-quarter of the center plate load at each end. The bearing surfaces of these end portions of the equalizing bolster are curved to

a radius of 20 ft. This permits a rocking movement of the equalizing bolster on the cross bolsters, and also provides for a limited amount of upward or downward movement of

may be partially carried back across the truck to the other equalizing system.

Because of the clearance provided between the side bear-

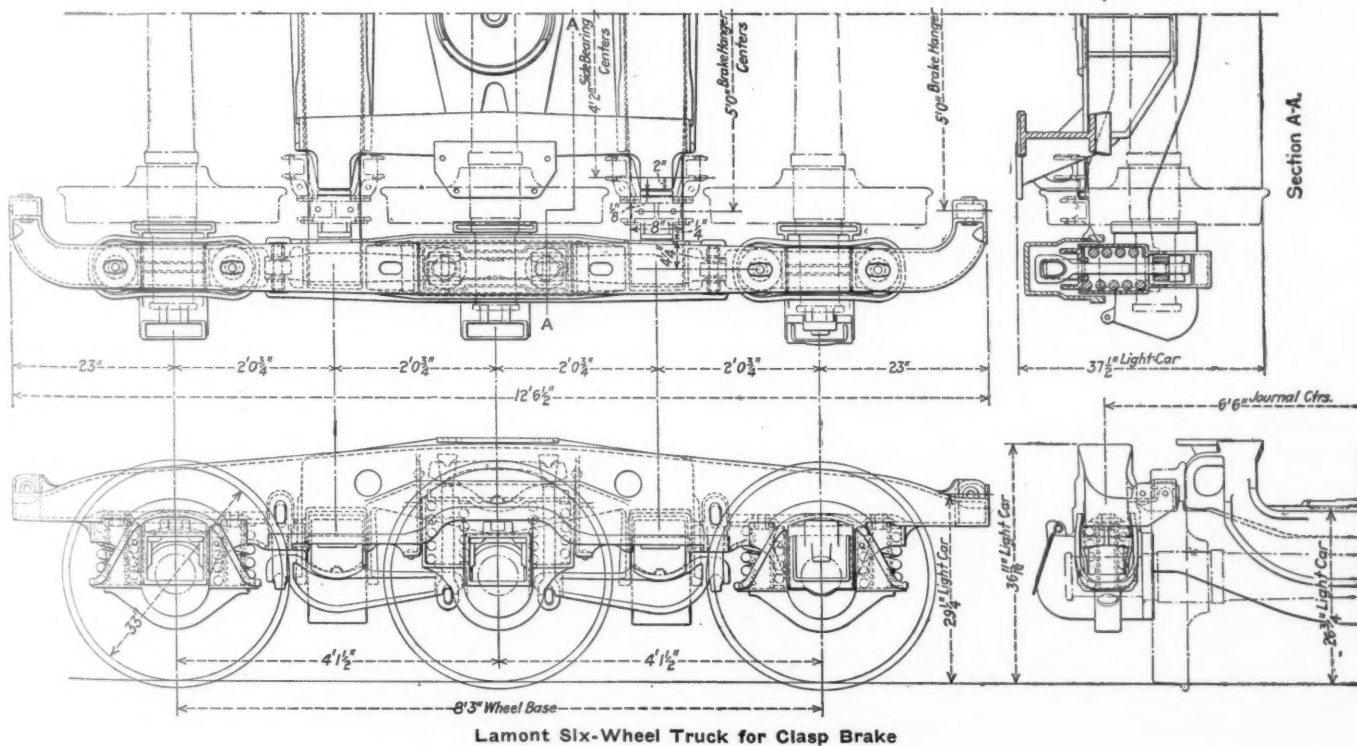


the ends of the cross bolsters as the wheels pass over inequalities in the surface of the track.

Under average track conditions this insures an equal distribution of the center plate load over the four points of delivery to the equalizing system. When a combination of

ings of the equalizing bolster and the cross bolster, very little clearance, if any, is necessary between the car body side bearings and the roller side bearings attached to the equalizing bolster.

The equalizing mechanism on each side of the truck con-



vertical movement of the end of a cross bolster and side motion of the car brings a side bearing of the equalizing bolster and cross bolster together, the additional load at this point is distributed through the equalizers on that side of the truck and, if the end of the other cross bolster is free, it

sists of two equalizing levers, two lever hangers and an equalizing beam. The mid point of the equalizing beam bears on the middle of a spring cap which spans the two coil springs of the middle journal box. The location and relationship of the parts are clearly shown in the general

drawing of the truck. The load delivered to either end of an equalizing bolster is taken up by an equalizing lever and delivered in the ratio of two to one, to the end and middle journals, respectively—to the end journal indirectly through the side frame, springs and journal box and to the middle journal through the lever hanger, equalizing beam, springs and journal box.

The journal boxes are of special design in which pockets have been provided on either side to receive the coil springs.



A Top View of the Truck, Showing Arrangement of Bolsters and Brake Rigging

Thus located, the springs support the maximum amount of dead load, they are protected through the equalizing mechanism against overloads and are in the best position to take up shocks from the individual wheels without passing them on to the equalizing system.

Double coil springs are used on the end journal boxes and single coils on the middle journal boxes. The inner coils used

on the end journal boxes have a free height $2\frac{1}{4}$ in. greater than the heavy outside coils. They are compressed to the height of the outer coils under the light weight of the car, and with this compression exert a force on each of the end journals of approximately 1,750 lb. The heavy coils are the same on both the end and middle boxes and are necessarily of high capacity, compressing only about $\frac{1}{8}$ in. under the light weight of the car. Because of this comparative lack of resiliency under the weight of the empty car the inner coils have been provided at the end journals as a protection against possible derailment. The middle wheels being free to act through the flexible equalizing mechanism, do not require the protection of the inner coil springs, and only the heavy coils are used.

The middle journal boxes are guided by the side frames on their ends only. Clearance is provided between the upper portion of the boxes and the side walls of the frames to permit freedom of lateral movement of the middle pair of wheels on curves. When the middle journal boxes move laterally, an inverted pendulum motion takes place in the equalizing lever hangers, suitable provisions for this movement being made in the bearing surfaces of the hangers, keys and connecting parts.

This truck has a wheel base 8 ft. 3 in., which is the shortest of any six-wheel truck yet developed. This has been an important factor in keeping down the weight of the trucks which, with the three-part bolster construction and clasp brakes, is 36,300 lb. per car. All parts of the truck are designed to carry a center plate load of 140,000 lb. and a 50 per cent overload on the side bearings without exceeding a fibre stress of 12,000 lb. per sq. in. All surfaces of contact between the journal boxes and the side frames are protected against wear by $\frac{3}{16}$ -in. hard steel liners. On the end journal boxes these liners are shaped to fit the top and sides of the boxes as well as the vertical flanges. For the middle journal boxes the liners are attached to the frame surfaces.

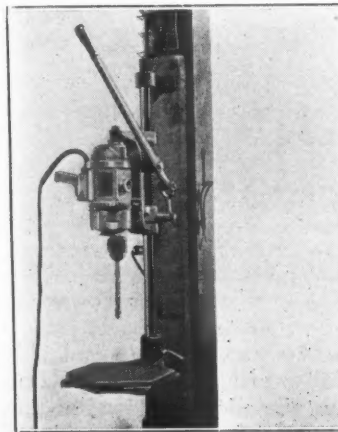
The truck has been designed for either clasp or single brakes. The trucks furnished for single brakes differ from those designed for the clasp brake rigging only in the shape of the side frames. For the single brake rigging the frames terminate at the outside spring pockets for the end journal boxes.

Adaptability Secured in New Post Drill

DETAILS of an application of Black & Becker portable electric drills to bench drill stands were given on page 740 of the November *Railway Mechanical Engineer*. Since that time the idea of the bench drill stand has been extended to make the stand attachable to a post or wall, whichever is more convenient. Standard portable electric drills of capacities from $\frac{3}{8}$ in. to $\frac{7}{8}$ in. are used in the new post or wall drill, and the principal change from the bench stand, previously described, has been to increase the length of the $1\frac{1}{8}$ in. steel shaft and to arrange for holding it rigidly to the post by means of heavy brackets at the top and bottom. One other change has been in the arrangement for raising, lowering or swinging the table. All adjustments of the table are secured by means of the clamping screw shown in the illustration.

Attachment of the drill to the stand may be easily and quickly accomplished. As shown in the illustration, the brackets carrying the drill can be raised, lowered or swung around on the vertical column and secured in any desired position by means of a split collar and clamping screw. A strong spiral spring returns the drill to the high position when the feed lever is released. As both the drill brackets

and drilling table have horizontal and vertical adjustments, the wall drill is an unusually flexible outfit, and for this reason is adaptable to a great variety of uses. It is made by the Black & Becker Manufacturing Co., Towson Heights, Baltimore, Md.



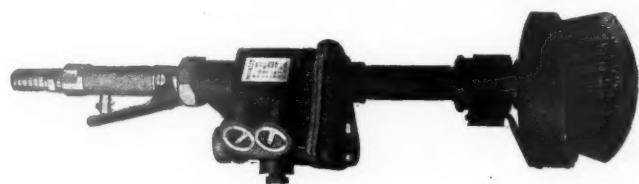
Black and Decker Post Drill

Specifications for the new post drill call for a column length of 46 in., vertical adjustment of drill $25\frac{1}{4}$ in., drilling radius 7 in., horizontal adjustment of drill 180 deg., feed by lever, $4\frac{1}{2}$ in., and net weight 80 lb.

The extra long feed lever, illustrated, gives a feed ratio of approximately six to one, or in other words, a pressure of 80 lb. applied to the handle feeds the drill under 480 lb. pressure.

Rotary Wire Brush for Cleaning Operations

A ROTARY wire brush has been designed by the Independent Pneumatic Tool Co., Chicago, for use with the No. 71 Thor pneumatic grinder. It is interchangeable



Thor Rotary Wire Brush Designed for Cleaning Operations

able with the grinding wheel, an arrangement which in reality provides two tools in one, since the machine may be used either as a pneumatic grinder with a 4 in. emery wheel, or as a rotary wire brush for cleaning operations.

The face of the brush is 5 in. in diameter and, as shown in the illustration, all wires are of equal length, being hair-pin shaped and made of specially treated steel. The concave back allows the wires to bend under pressure without breaking. By using this brush a large amount of time can be saved over that required by hand for the removal of paint, rust, scale, grit, etc. It is particularly useful on steel cars, tanks, frames, castings, sheet metal and other materials.

Duplex Compensating Suspension for Tractors

THE Baker R & L Company, Cleveland, Ohio, announces its new series C models of electric industrial tractors and trucks replacing the series B machines produced during the past three and one-half years. An important feature of the new machines is the ingenious manner in which the heavy thrusts of the axle and the driving and braking strains are resisted through what is known as the duplex compensating suspension. This suspension positively resists all torque and driving strain, provides for free spring action and maintains accurate alinement at all times between the axle and the frame.

Referring to Fig. 1, it will be seen that the axle is suspended by means of two V-shaped yokes through large ball

when torque reactions are taken through sliding surfaces used in conventional constructions. The large, lubricated, trunnion bearings and adjustable ball and socket joints insure

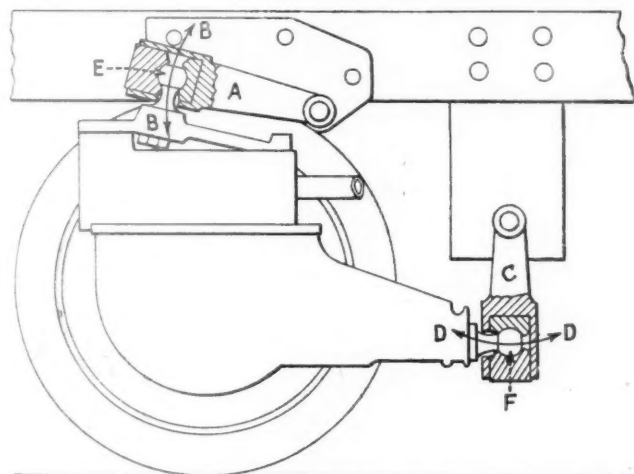


Fig. 1—Line Drawing of Duplex Compensating Suspension

and socket joints on the axle and trunnion bearings on the truck frame. The horizontal or driving yoke A transmits the driving power from the axle to the frame while the vertical or torque yoke C resists "torque" or the tendency of the axle to rotate and also has a slight forward and backward motion when compensating for the angular movement of the driving yoke.

The double concentric helical springs (not shown on the drawing) support only the truck load. They are loosely seated in the frame and axle members which are tied together against rebound with spring bolts, swiveling in their sockets. The flexibility provided by this construction permits the driving axle to negotiate either smooth or rough road surfaces, increasing traction without loss of power efficiency or clamping or binding the parts. Of equal importance is the elimination of maintenance expense, looseness and rattling

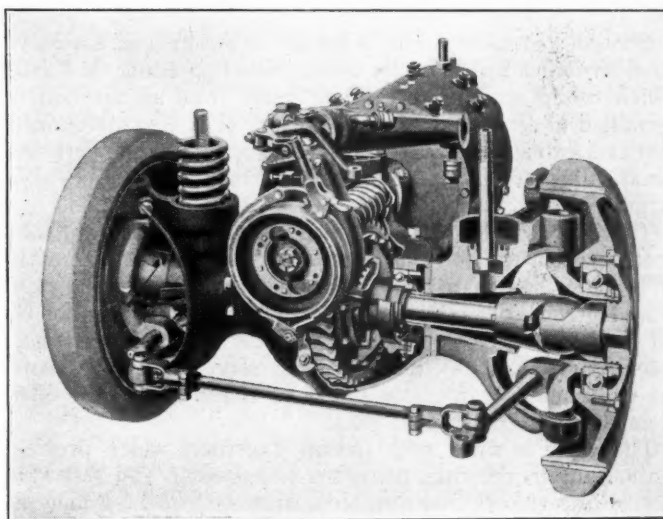


Fig. 2.—Driving Axle Equipped with Duplex Compensating Suspension

durability of parts for the life of the machine. A phantom view of the mechanism is shown in Fig. 2.

Emphasis is laid on the importance of the duplex compensating suspension because machines of the industrial

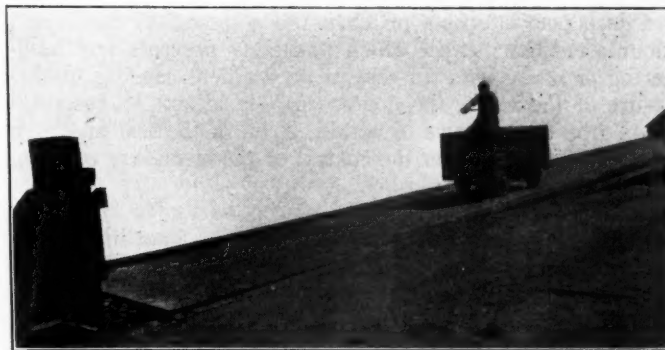


Fig. 3.—View Showing Method of Making Impact Tests

truck type are subjected to extremely severe torque stresses. Although operated at slow speed they are frequently bumped into heavy objects and throughout their life must resist the

strains coming from abrupt starting and stopping. In fact, many operators change abruptly from full speed ahead to full speed reverse, subjecting the machine to heavier strains than are ever encountered in other vehicle work.

Sample machines incorporating this new feature were subjected to some unusual tests of a spectacular nature and stood up satisfactorily under strains which would easily have

caused failure to trucks equipped with a less rugged and flexible type of spring suspension. In one of the tests a tractor, shown in Fig. 3, equipped with duplex compensating suspension was operated down a $12\frac{1}{2}$ per cent ramp at 10 miles per hour as an impact test. The tractor struck a blow of 46 tons against the bumping post without damage to the spring suspension or other parts.

Automatic Valves Reduce Boiler Shut Downs

MODERN power plants with their batteries of boilers, headers and many branch steam pipes, are susceptible to disastrous accidents and expensive shutdowns in the case of bursting boiler tubes or steam pipes. As a safety feature, the Golden-Anderson Valve Specialty Co., Pittsburgh, Pa., has developed an automatic, double-cushioned, triple acting, non-return valve for application in the main steam lines. The valve is entirely automatic in action, and in case of a split boiler tube or broken steam pipe, a reduction of pressure of 1 lb. or more below the pressure of the other boilers will cause the valve to close and isolate the boiler involved, thus allowing the other boilers to give uninterrupted service.

Should a break occur in a header or steam line, the valve on every boiler will instantly close, thus eliminating the havoc which would occur were the live steam from all the boilers permitted to escape through the break. It is also maintained that this valve equalizes the load between all the boilers automatically and makes possible the immediate location of a lagging or sluggish boiler.

There is no need for hand operation as the valve automatically cuts in the boiler or cuts it out as the pressure equals or becomes less than the other boilers. If the steam gage should become defective and inaccurate the boiler cannot be cut in prematurely, as may happen with ordinary hand stop globe valves. At any time while in service under pressure the valve may be instantly tested or closed from the boiler room floor or other remote point.

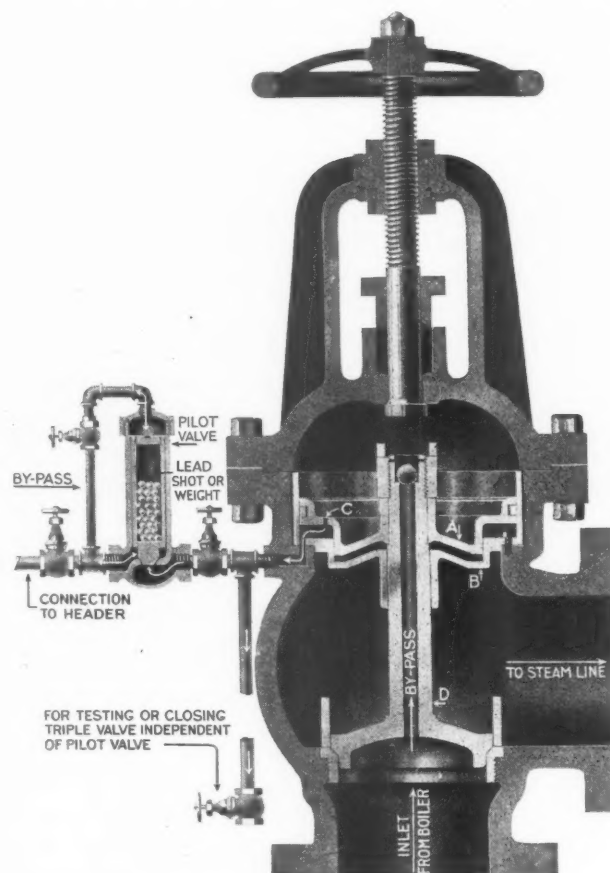
The valve is fitted with special dash pots which provide against any hammering, pounding or spinning, and this feature assures smooth and durable operation. In the design of the valve, particular attention has been paid to provide adequate strength for the constant strain and vibration of a piping system. Perfect alignment is secured at all times and this prevents the binding and sticking commonly encountered.

Referring to the sectional view of the valve, it will be noted that the outside dash pot *B* is securely anchored to a shoulder of the valve body by numerous cap bolts. This dash pot acts as a cylinder for the inside dash pot *A* which is firmly fastened to valve disk *D* by a large lock nut. The design of the two dash pots affords a primary and a secondary cushioning (double cushion) effect which positively prevents any hammering or pounding. In case of an accident causing sudden closure of the valve, the double cushion allows an instantaneous drop of the valve to within $\frac{1}{8}$ in. of the seat and then it closes smoothly under the control of the secondary cushion, preventing disastrous closure.

Automatic valves are usually placed on top of the boiler nozzle or installed in the steam line leading from the boiler; also in branch lines leading from the header. The automatic shot pilot valve is located adjacent to the main valve and piped into the header at about 15 ft. from the main valve on its outlet side. The automatic testing feature is connected between the pilot and main valve and extended to the boiler room floor. Boiler pressure is applied underneath the disk *D* and the valve, being balanced, will open automatically whenever the pressure underneath the disk equals that above it. On reverse steam flow, as a result of less pressure beneath the

disk *D* than above it, the valve will operate within 1 lb. variation.

In the case of a broken steam line or header with the valve working at 150 lb. pressure and the pilot valve set for 8 lb. differential, the instant pressure above the main valve disk drops to 142 lb. or less, it will permit the pilot valve to open and release the steam from between the dash pots. The main valve will then be instantly closed by the boiler pressure accumulating above dash pot *A* through by-pass in valve disk *D*, thereby shutting off all steam flow through the valve. The differential pressure may be decreased or increased by



Golden-Anderson Automatic, Non Return Valve

changing the weight of shot in the pilot valve. An 8 lb. differential is usually maintained which prevents premature closing or tripping on unusual steam requirements.

The valve is equipped with a hand wheel and may be closed at any time like an ordinary stop valve. It will be noted, however, that the stem is not connected to the disk, but merely bears against it. Therefore, when testing a boiler hydrostatically the automatic valve can be left in automatic position, which allows it to float during the test and avoids strain on its parts.

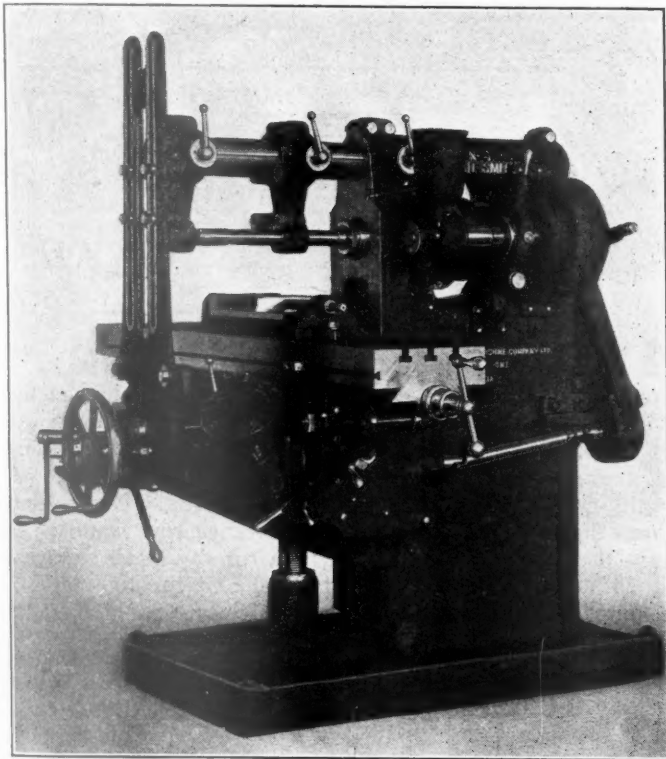
An automatic valve should be tested automatically. By

means of the automatic testing feature of this valve, it is possible to exhaust the steam between the dash pots at any time and determine whether the valve will close or not. The Golden-Anderson automatic valves are made in different

sizes and several different patterns, including the angle pattern, globe pattern, vertical discharge elbow pattern, downward discharge elbow pattern, cross pattern, globe pattern for use where head room is limited, and others.

Cone Drive Plain Milling Machine

A NEW No. 4 plain milling machine with cone type drive has been developed recently by the Ford-Smith Machine Company, Ltd., Hamilton, Canada. As in the usual milling machine construction, special attention has been given to locating control handles for all movements of the knee and table within easy reach of the operator. In



Ford-Smith No. 4 Plain Miller Equipped With Cone Drive

addition, rapid power traverse in all directions is secured, together with safety clips. An exceptional feed range, varying from .006 in. to 1.56 in. per revolution of the spindle, is provided. Rigidity of the knee is secured by eliminating holes in either the top or sides. A narrow guide is provided for the saddle on the knee. As shown in the illustration, a feed dial at the operator's hand indicates all feeds. Power

feeds and automatic trips are arranged in all directions.

Special attention is called to the positive locking of the arbor supports on the overarm and of the overarm in the column. The column is of box section construction with heavy walls and bars for supporting the knee and bearings. Micrometer adjustments by means of graduated collars reading to 1/1000 in. are provided for the table screw, cross screw and elevating screw. The table is unusually stiff with wide bearings and great depth. The feed box is not carried on the column in the usual manner, but is bolted to an extension of the saddle on the knee. This construction makes possible the arrangement of the dial feed hand wheel, handy to the operator, at the working position at the front of the knee.

Twelve changes of speed are obtained from the dial which, in conjunction with the coarse feed handle at the side of the column, gives 24 changes when the back gear is in mesh. For ordinary work the feed is driven from the feed pinion geared to the spindle, but when the back gears are engaged the feed may be driven from the cone pinion, which speeds up the whole feed mechanism 3 to 1, or 10.8 to 1, according to the ratio of the back gear engaged, thus making possible exceptionally coarse feeds.

The rapid power lever must be held in position by hand while the rapid power is engaged, making the mechanism practically fool proof. As an extra precaution, however, a safety trip device is provided should the rapid power or feed overrun at any time. The countershaft is of the two-speed, friction type with self-oiling bearings. Friction clutches are of an improved expanding type carefully balanced with means of taking up wear.

Specifications for the Ford-Smith No. 4 miller call for a table working surface 71 in. by 14 1/4 in. Three 3/4 in. T-slots are provided. The longitudinal, cross and vertical traverse are 42 in., 12 in. and 20 in., respectively. The distance from the face of the column to the base is 30 in. Eighteen spindle speeds, ranging from 14 to 450 r.p.m., are provided. The overarm diameter is 4 3/4 in., and the distance from the center of the arbor to the underside of the arm is 7 1/4 in. Twenty-four speeds are provided with the back gear in and 12 without the back gear. The feeds per revolution of spindle range from .002 in. to .39 in. for the cross and elevation. Rapid power traverse for the longitudinal, cross and vertical movements are at the rates of 130, 33 and 11 in. per min., respectively.

Gap Crane Saves Erecting Shop Headroom

ONE of the most formidable problems imposed in the design of modern locomotive repair shops is to provide a traveling crane capable of lifting a complete locomotive high enough so that it may be carried over the tops of other engines in the shop to be set down at some other point. With the rapid increase in the length and weight of locomotives, so that 90-ft. cranes are now common, this utility has added greatly to the cost of erecting shops. One feature that has been especially troublesome is the great headroom required. Thus, with adequate allowance made for clearance, the height of a locomotive on the floor, plus that of another one being passed over the top of it, plus the depth of the

traveling crane and its trolley, gives a total height of 54 to 56 ft. or more from the floor to the underside of the roof trusses. This height is obviously a source of great expense in construction and is also a disadvantage in the operation of the shop because of the waste of heat, inefficient illumination and disadvantageous height to which the crane operator is removed from the floor.

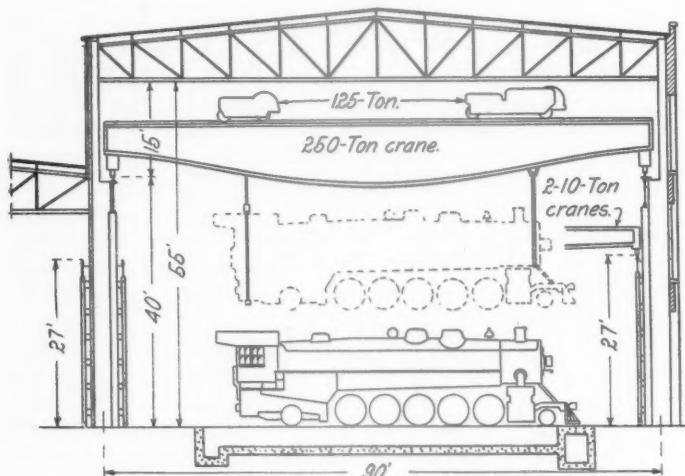
An appreciation of these shortcomings of the prevailing arrangement of shop structures has led to the development of the "gap crane" erecting shop by which from 15 to 18 ft. of the vertical height of the shop building may be saved. The idea is simple. The girders of the crane are spread apart a

sufficient distance to permit the locomotive to be lifted up between them. As a consequence the crane may occupy the same vertical position as the locomotive, and the vertical height between the floor and the underside of the roof trusses consists of the height of the locomotive on the floor, plus the height of the locomotive in the air, plus the necessary clearance. The idea will be understood more clearly after an examination of the illustrations.

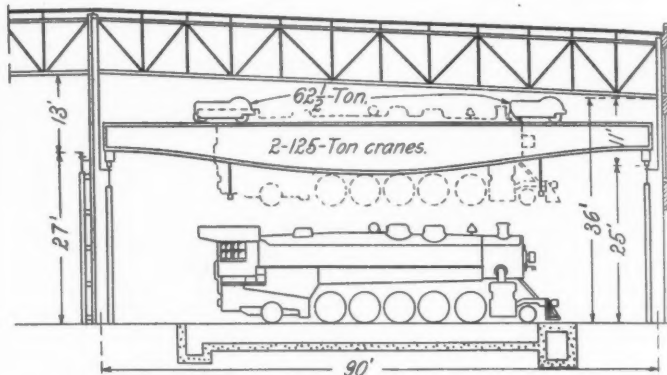
The gap crane is made up of four girders arranged in

be provided and the two arranged to serve as twin cranes.

One point not to be overlooked in considering this development is the need in any modern shop of auxiliary or messenger cranes of 10 to 20 tons capacity. In the modern shop where high headroom has had to be provided for the lift-over operations, the auxiliary cranes have been usually operated on a separate runway about 27 ft. above the floor and therefore from 12 to 16 ft. below the runway upon which the large capacity crane is supported and thus the small cranes

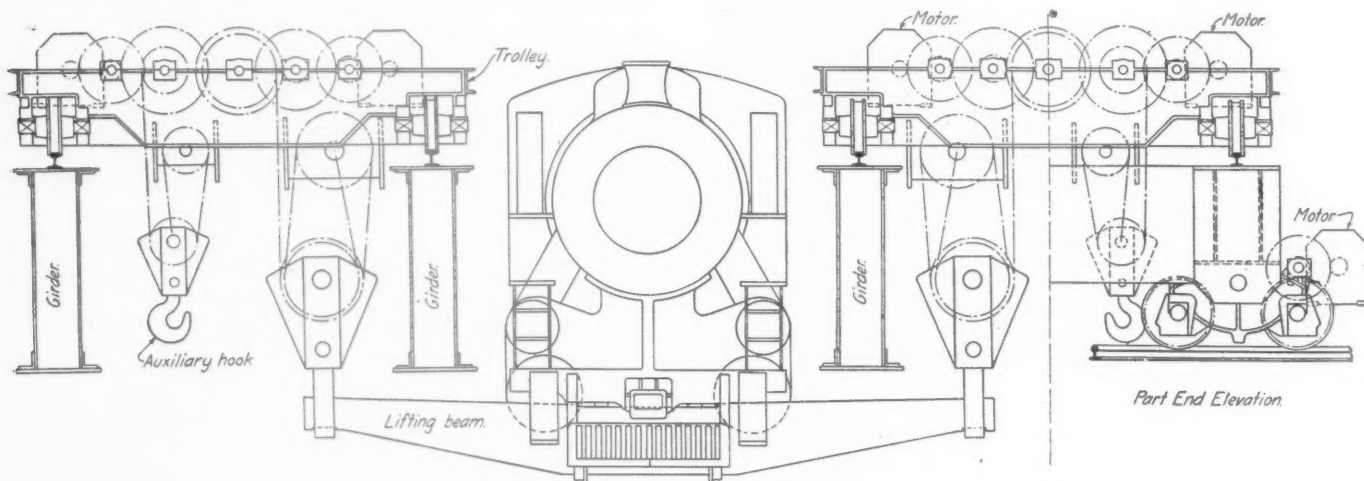


How a Gap Crane Reduces the Required Headroom in an Engine Shop



pairs with the two pairs separated a sufficient distance to allow the entire locomotive to be lifted up between them. Four trolleys of 62½ tons capacity each are used in pairs with the hooks or lifting devices at the ends of the fall lines attached to lifting beams which engage the front and rear ends of the locomotive. The lifting beam at the front end may be placed either under the extended sills or side frames which support the pilot truck or may be provided with adjustable saddle blocks and placed under the front end of the

are enabled to operate without any appreciable interference with the large cranes. With the use of the gap crane in shops of 10 to 12 pits in erecting aisles, it is believed that the use of a single crane runway for both the heavy and light capacity cranes will work out very satisfactorily. With larger shops than this a more satisfactory arrangement would be to have the heavy cranes operated on a runway at an elevation of 24 to 27 ft. above the floor level and the light cranes mounted on a runway sufficiently high to enable them to



Cross Sectional Elevation of a Gap Crane

boiler, thus giving the same advantages as the sling rig but with greater resistance against overturning, a safety feature of importance.

The gap crane may be constructed as a single unit or the two pairs of girders may be arranged to serve as independent "twin" cranes with provision for multiple unit control when they are used together for lifting a locomotive. Another feature of this development is the facility it offers for adaptation to old shops equipped with a crane of limited capacity. Thus, if a shop is equipped with a traveling crane of 120 or 125 tons capacity, a second crane of the same capacity may

operate over the tops of the heavy cranes. While this would involve some loss of the headroom saved by the use of the gap crane, it would accomplish a considerable saving in the cost of the steel frame of the building as compared with the case where the heavy section columns must be extended to the height necessary to support the heavy crane at the high elevation.

The idea of the "gap crane" erecting shop was conceived by Harvey Shoemaker, formerly superintendent of motive power of the Bangor & Aroostook, and construction work will be carried out by the H. K. Ferguson Co., Cleveland, Ohio.

Heavy Duty Ball Bearing Dry Grinder

THE Marschke Manufacturing Co., Indianapolis, Ind., has developed recently a No. 18 heavy duty, ball-bearing grinder, having four bearings. The machine is designed to swing either 18 in. or 20 in. by 3 in. wheels for dry grinding. The hood is adjustable, always bringing the wheel to the front of the hood, and an automatic control, spark

plate adjustment is provided. The spark plate adjusts itself to the wheel as the steady rest is adjusted to the wheel by moving the hood. This is done by one hand wheel, no tools being required.

The machine, illustrated, is provided with an exhaust fan, mounted inside the base. The fan operates on S. K. F. ball bearings and runs by means of a silent, high speed chain, all parts being enclosed in a housing kept free from dust and grit. The machine is equipped with or without an exhaust fan, as may be desired. The starter is mounted on the back of the door and opens with the door, permitting access to the blower. The machine is furnished with either a handle or push button starter. The hood support, which is also the outer ell for the exhaust, is equipped with an opening directly underneath the hood and answers for several purposes. It is used as a clean-out, and, when grinding brass, can be opened, the heavy brass particles being collected in a container underneath. This construction enables the brass particles to be saved and sold with other brass scrap.

Specifications for the new 18-in. dry grinder call for a $7\frac{1}{2}$ hp. motor drive. The distance from the floor to the center of the arbor is 34 in. and the floor space required is 32 in. by 64 in. The speed of the motor under no load is 1,200 r.p.m.; under full load, approximately 1,160 r.p.m. When direct current motor drive is desired, a B. F. Sturtevant motor is applied and when alternating current is desired a Marschke motor, designed especially for this work, is used.



Marschke No. 18 Ball Bearing, Dry Grinder

Rigidly Constructed Auto-Transformer Starter

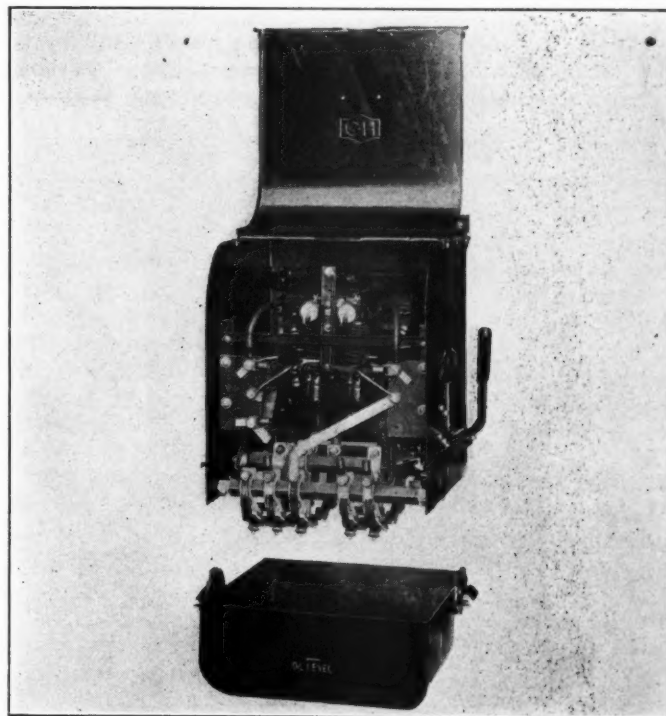
THE engineering department of The Cutler-Hammer Mfg. Co., Milwaukee, Wis., has devised an auto-transformer starter of unusually rigid construction to meet the severe requirements of the large industrial plant and mine, as well as that of the small mill and factory. The simple steel construction—using no wood or castings whatsoever—the absence of flexible moving leads, and the ease of inspection of the contacts and adjustments of the relays, enable this starter to give continuous and satisfactory service at a low upkeep cost. This starter, which is shown in the illustration, consists of two auto-transformers, commutating mechanism, low voltage release and duplex overload relay, all enclosed in a sheet metal case with the operating lever outside. The case is strongly reinforced with angle iron, and has a hinged cover which can be lifted to expose the transformers and relay. The transformers and case are carried directly on the supporting brackets and may be readily mounted on the wall, switchboard, or any post or pedestal.

The starter is operated by moving the operating lever forward to the starting position and then backward to the running position, where it is held in place by the low-voltage mechanism. Interlocks prevent moving the lever directly to the running position. If released in the first or starting position, the lever is returned to neutral by a spring. Locked in the neutral position it prevents unauthorized operation.

Two auto-transformers connected in open delta are used for both two and three phase service. The special construction of the transformer core allows either coil to be easily and quickly replaced. Each coil is provided with three accessible taps which give 50, 65 and 80 per cent of full line voltage.

The low-voltage mechanism is mounted inside the case on the right-hand side. A wire from the armature of the release coil extends through the case near the operating handle and is bent to form a hook, a slight pull on which releases the starter and returns the handle to neutral. Remote control

of stopping may be obtained by inserting one or more normally closed pushbutton switches in the low-voltage



Starter With Oil Tank Lowered and Cover Thrown Back

circuit. Any push button will release the starter mechanism.

A duplex overload relay with a true inverse time limit movement is mounted inside the case on the transformer

assembly in such a position that adjustments for time and current values can be readily made. This duplex relay is equivalent to two overload relays, each in series with one of two phases. The underwriters' rules do not require the installation of a disconnecting knife switch or circuit breaker ahead of this starter when thus equipped, because the starter

completely disconnects the motor from the supply line when released by an overload.

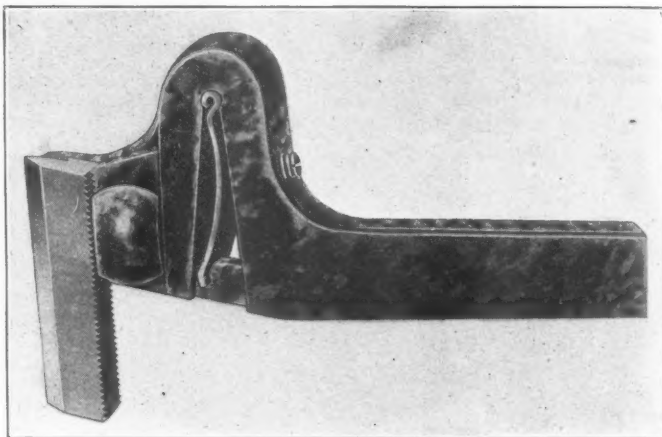
These starters are made in various sizes for the operation of two or three phase induction motors rated between 5 and 100 hp. on standard commercial voltages between 110 and 2,200 and at frequencies of 60, 50, 33 and 25 cycles per sec.

Spring Threading Tool of New Design

THE old goose neck principle is incorporated in a new threading tool made by the Ready Tool Company, Bridgeport, Conn., for the purpose of eliminating chatter and to enable the operator to cut smooth threads on all lathe work. The cutter is held at an angle of 15 deg. and the side angles are accurately ground so as to cut a practically perfect 60 deg. thread. The cutter, being held on the left side of the holder, enables the operator to work close up to a shoulder. The spring allows threaded work to be finished smoothly and as only high speed cutters are provided threading can be done at high speeds.

Notched teeth are cut in the back of the cutter and in the front of the dog, the two being clamped together with a bolt holding the dog to the tool holder, which overcomes any possibility of the cutter slipping. An auxiliary spring with a set screw is incorporated in the holder and by increasing the pressure, heavy pitches, such as four, six and eight, can be cut just as smoothly as the finer ones, in which latter case the auxiliary spring is released.

Only the top surface of the cutter requires to be ground, thus assuring long life for the tool and accurate threads. A Woodruff key in the bottom overcomes any possible side

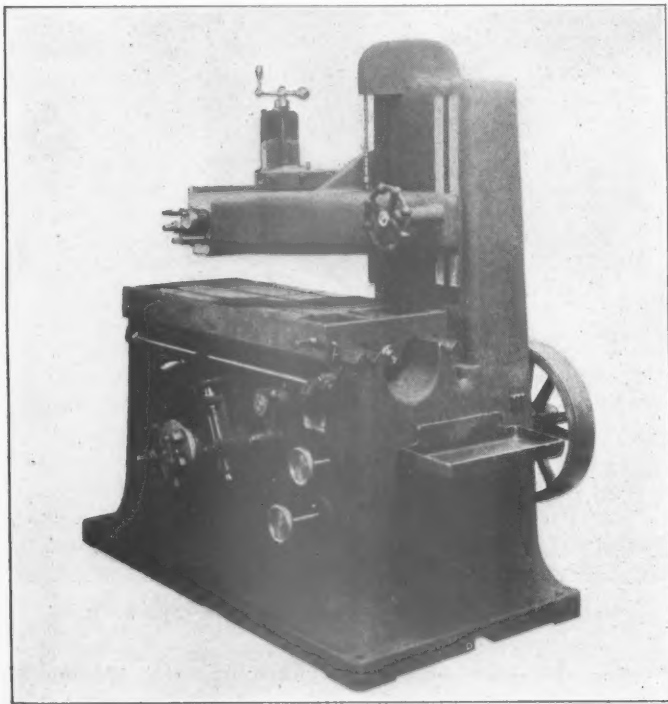


Ready Spring Threading Tool

thrust. "V" cutters as well as U. S. standard pitches and chasers are carried in stock for immediate delivery. This tool is made in right hand offsets, size $\frac{1}{2}$ by 1 by 7 in.

Combination Clutch Brake for Shaping Planer

THE latest type of Coulter shaping planer, built by the Automatic Machine Co., Bridgeport, Conn., is shown in the illustration, and a noteworthy feature in its con-



Coulter Shaping Planer Equipped With Clutch Brake

struction is the combination clutch brake mechanism. This is operated from the front of the machine, and enables the table to be stopped and started instantly without changing the motor or countershaft speeds. In fact, with this arrangement, no countershaft is necessary on the belt-driven model, as it can be belted directly to the main line shaft, thereby saving space where head room is limited. A length of stroke indicator is also provided together with clamps for clamping the down feed while the cross feed is working, or vice versa. These features are especially desirable for many tool room machine operations.

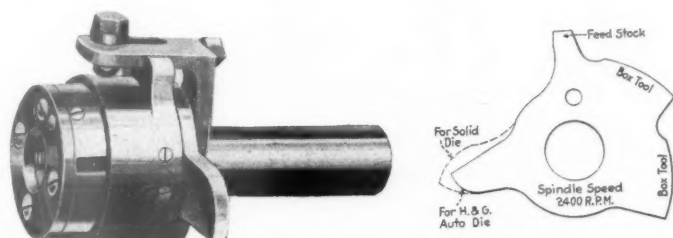
The clutch brake mechanism consists of a raybestos lined brake and a main driving pulley made up of two concentric wheels, the inside rim of one and the outside rim of the other being bevelled at an angle which by repeated tests has been shown to be most satisfactory for the purpose. Movement of the operating handle to throw out the clutch applies the brake simultaneously. There is a split nut on the driving shaft so that the amount of friction in the clutch can be adjusted. The large bearing surface and large diameter result in a minimum of wear, maximum torque for a given pressure and absence of appreciable heating. The whole arrangement is simple, with few parts to get out of order, a valuable feature for any machine in railroad shop use.

Other features, making the new Coulter planer of especial interest, are the shaper advantages of quick return stroke, variable speeds and ability to cut to a shoulder, with planer accuracy and table capacity. The maximum stroke can be taken with the same accuracy as a shorter one, and this maximum stroke can be taken anywhere on the table by merely positioning it under the tool without disturbing the work.

Redesigned Trip Levers for Die Heads

THE Eastern Machine Screw Corporation, New Haven, Conn., has developed a new self-opening die head for use on Brown & Sharpe automatics, which is said to practically double the production of button dies. The principle by which the chasers are held and operated with the positive bearing directly over the cutting edge is the same as in all H. & G. die heads, but changes have been made in the method of drive and in the design of the trip lever, as shown in the illustration.

Previously the head was kept from turning in the floating



Style D, H. & G. Die Head with New Method of Drive and Trip Lever

shank by a pin through the shank proper engaging and traveling in diametrically opposite slots in the floating shank. As redesigned, this is accomplished by an extension on the shell of the head which engages both sides of the arm of the floating shank that overhangs the body. This brings the drive further from the axis of the die head and decreases the fric-

tion to a negligible quantity, with the result that the coarsest pitch which the machine will pull is threaded without friction or cramp in the head.

At the same time the design of the trip lever has been changed to make it sensitive for the finest threads up to 90 per in. These changes make it a simple matter to install the new heads on any Brown & Sharpe automatic.

The layout of the cams is much simplified, inasmuch as they do not have to conform to the lead of the screw either on the advance or reverse, simply starting the thread and advancing the turret somewhat less than the amount of the lead, after which the die head pulls out and trips at the proper point.

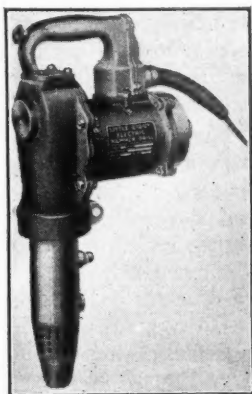
The adjustment for length of thread is accurately made by an adjusting screw which brings the tripping button to the proper point. With this head it is possible to cut to a shoulder or a given point with great precision and simple adjustment is provided for the depth of cut which can be controlled to less than .0005 in. By the use of these die heads, it is possible to obtain an additional speed, inasmuch as the reverse belt can be used for forward driving at a more favorable speed.

The illustration shows a cam outline and compares the solid die cam with the self-opening die cam, showing that the change is very simple. This particular cam is threading at 2,400 r.p.m. One cam can be used for threading many different pitch screws. High speed steel chasers, provided with the proper clearances, produce straight, smooth threads at extremely high speeds.

Electric Hammer Drill of Novel Design

A HAMMER DRILL, driven by an electric motor instead of compressed air, is being manufactured by the Chicago Pneumatic Tool Company, New York.

The drill is known as the Little Giant electric hammer drill, and is said to be particularly adapted for drilling concrete, soft stone and for light chipping of metals. The hammer blow, which is delivered by a piston on the drill steel or chisel, is produced by pneumatic impact. At the instant the blow is struck, the piston is running free of all mechanical parts and very little shock or vibration is transmitted to the electrical parts of the tool. The tool is so balanced that when held loosely in the hand, the line of center of gravity falls between the third and middle fingers of the hand and lies within the barrel of



Electric Hammer Drill

the tool, causing the tool to hang vertically and be easily controlled. The switch is located in the handle. All bearings are of the ball type and provision is made for the lubrication of all revolving and reciprocating parts. The gears and other portions of the moving parts subject to wear are all hardened. A universal type of motor is used which will operate either on direct or alternating current and motors will be supplied for either 110 or 220 volts.

A special feature of this drill is a live air device for clearing the hole of the cutting while drilling. The purpose of this device is to keep the hole clear, so that when holes are drilled in stone or concrete in a downward position the air will dispose of powdered cuttings which absorb and waste much of the force of the blow and tend to choke up the hole. This makes it possible not only to deliver the full force of the blow on the stone or concrete, but makes it easy to get the drill bit out of the hole. Hollow steels or bits are furnished for this purpose.

The efficiency and convenience of electric operated tools are well known and the Little Giant hammer drill marks one of the first attempts to operate a hammer by electricity.

Fibrous Metallic Packing for General Use

FOR packing reciprocating, or revolving rods, glands, cocks and valves of all kinds, a metallic packing known as "Red Seal" has been introduced to the American market by General Engineering Accessories, Ltd., London. The feature of particular interest about this packing is its physical composition. It is a plastic metallic composition, "a fibrous mass, composed of 88 per cent impalpable powder

of special alloy so fine as to pass through a sieve with 10,000 meshes per square inch." The packing is readily broken up by hand and can be kneaded, a characteristic which enables it to be packed into a gland of any shape and be distributed evenly. Tightening the gland compresses the packing together until it becomes a metallic ring, stated to be practically as impervious as a collar of steel. At the same time,

due to the exceeding fineness and structure of the alloy, it cannot score the rod or stem which it surrounds. The use of a small quantity of cylinder oil mixed with the packing will facilitate packing inverted glands or glands in awkward positions.

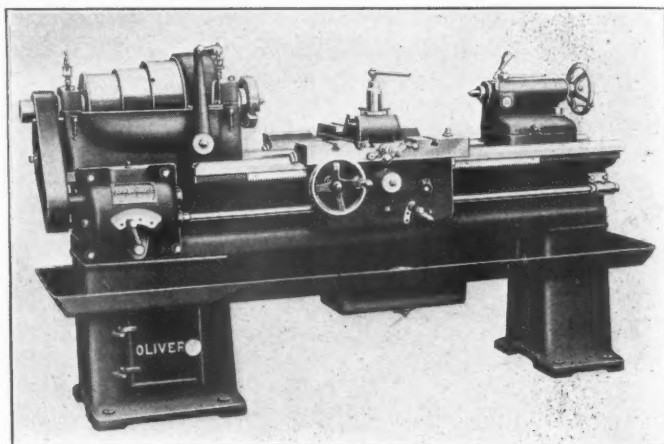
Advantages claimed for Red Seal Packing are that it never

scores or tapers a rod, never burns or gets hot, is equally efficient for superheated steam, hot or cold water, tar or ammonia, requires no skill to apply, does not harden, is self-lubricating and obviates the necessity of keeping a range of sizes in stock. It is being sold in this country by John Simmons Company, New York.

Simplicity Features New Oliver Lathe

AFTER working on its design for several years, the Oliver Machinery Co., Grand Rapids, Mich., has developed a new 16-in. rapid production lathe, of which perhaps the most notable feature is its comparatively simple construction. By the elimination of more or less non-essential working parts and by strengthening the lathe at points subject to heavy working stress, a high production tool has been developed, which is now giving satisfactory service in several plants.

The simplest form of the lathe with a 3-step cone pulley headstock is shown in the illustration. The driving cone is large in diameter and each step of the cone is wide. This allows for a powerful drive at comparatively high speed. The large lever shown in the front of the headstock operates the starting and stopping clutch. The efficiency of this clutch and the ease of operating the lever are important elements in securing rapid production. The headstock may be furnished with double back gears or with single back gears, as desired. Four feeds are provided through the quick change gear box. The tool post is mounted on a carriage of substantial construction, as shown. Provision is made for a continuous

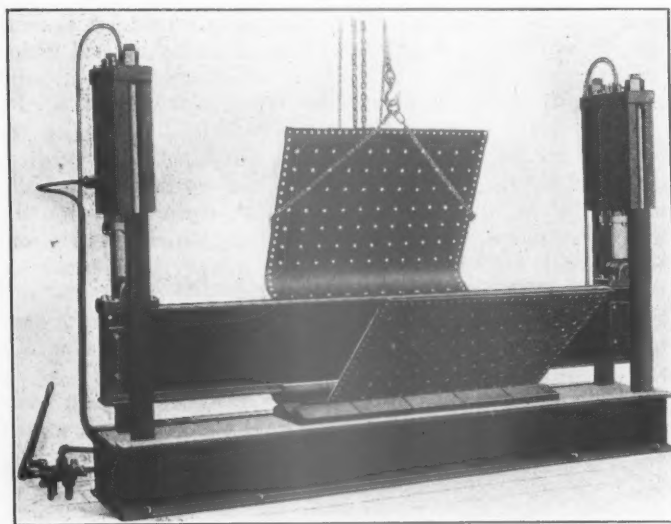


Oliver 16-In. Production Lathe

flow of cutting compound at the cutting point. All working parts are carefully guarded.

Plate Press With Sectional Dies

A PLATE PRESS designed for use with sectional dies has been developed by the Houston, Stanwood & Gamble Co., Cincinnati, Ohio. The machine consists of a simple arrangement of cross-beam, connected to rams at



Sectional Dies Produce Accurate, Interchangeable Work

each end by bearings, having swivel pins which give the beam flexibility, and allows it to adjust itself to any unevenness of the work. The frame consists of heavy uprights, bolted through substantial cylinders at the top; and bolted through a heavy reinforced base casting at the bottom. The upper sectional dies are placed on the beam of the machine in a simple manner. A bar extended through a hole in each die enables it to be lifted by two men and slipped on at the end of the beam. It is then moved along to any position which may be desired.

The lower sectional dies are placed on the bed of the machine and aligned with the upper dies by means of the side channels which reinforce the bed. These side channels extend above the heavy base casting for that purpose. The operating lever for controlling both working and return stroke is conveniently located and is always within easy reach of the operator. The entire upper part of the machine is flexible to a necessary degree which takes care of any uneven strains and stresses during the working stroke.

The operation of bending a wrapper sheet is shown in the illustration, and the press is particularly adapted for this class of work, the work possessing the added advantage of interchangeability. The machine is built in various sizes and capacities, and is designed to operate by hydraulic or compressed air pressure.

Headlight Combines Strength and Lightness

THE American Metal Products Company, Brooklyn, N. Y., has put on the market under the trade name "Ampro" a new electric headlight cast from a specially strong non-corrosive metal. The headlight weighs complete

with mirror glass reflector 45 lb. On account of its light weight one man can install the "Ampro" without the use of tackle or special rigging.

Some of the features claimed for this new lightweight

headlight are its weather tight and air tight construction; interchangeable straight and angle side number doors; improved latches which keep the doors intact under severe vibration; 14-in. mirror glass reflectors giving the maximum illumination required by the Interstate Commerce Commission; a new improved positive focusing device so constructed

as to insure against breaking or bending of wires; and a specially designed positive electrical contact block which, when once wired, stays wired.

The "Ampro" headlight is readily fastened to the bracket on the smoke box door, or wherever it may be located, by means of four bolts through the legs.

Improvements in Twist Drill Grinder

THE original New Yankee twist drill grinder, as made by the Wilmarth & Morman Co., Grand Rapids, Mich., was an improvement over previous types because preliminary calipering was eliminated, and positioning of the drill made entirely automatic. The only adjustment required

provided with a new attachment by means of which straight and taper shank drills can be readily ground without any time consuming adjustments. The operation of the grinder is shown in the illustrations. Figs. 1 and 2 illustrate how long, straight and taper, collared shank drills, respectively, are positioned. When the body of taper and collared shank drills becomes too short to be supported by the sliding V block, Fig. 2, this part is thrown out and the shank of the drill is supported by a center detail in the elevating tailstock. Fig. 3 shows how a short, straight shank drill is positioned in the holder for grinding.

Nine belt and eight motor-driven styles of twist drill grinder are offered. These are made up in different combinations from four holders having the following capacities: No. 52 to 5/8 in., 3/32 to 1 1/2 in., 1/4 to 2 1/2 in., and 1/2 to 4 in. Each machine is equipped with means for obtaining different clearance angles and includes a built-in wheel truing device.

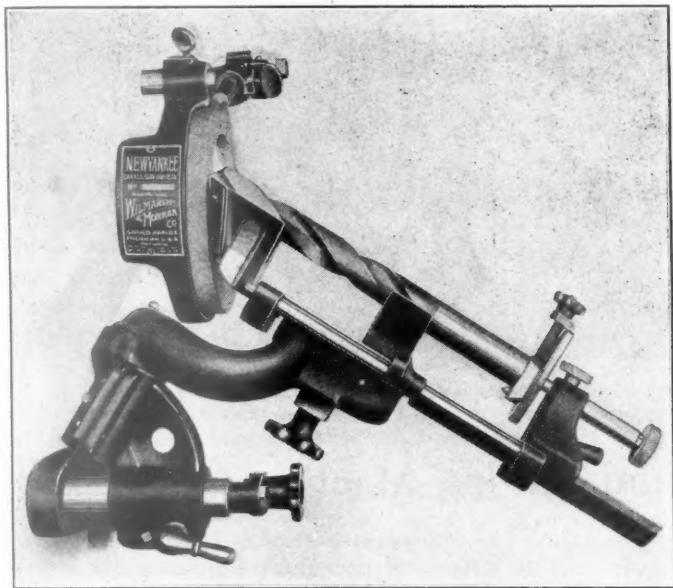


Fig. 1—Method of Holding Long Straight Shank Drill

was the setting of the tailstock for the various lengths of drills. This style of drill grinder, adapted to the grinding of straight shank drills only, remained standard with the Wilmarth & Morman Co. until the advent of taper and collared shank drills made a special attachment necessary.

The recently improved New Yankee drill grinder is pro-

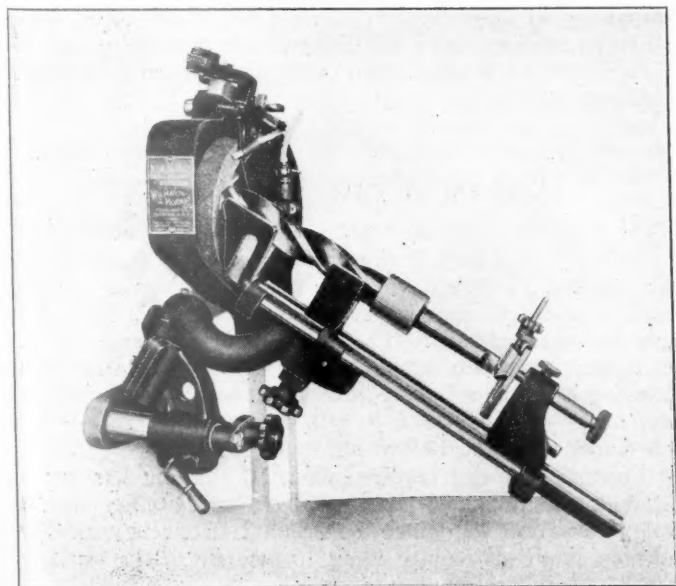


Fig. 2—Grinding a Taper, Collared Shank Drill

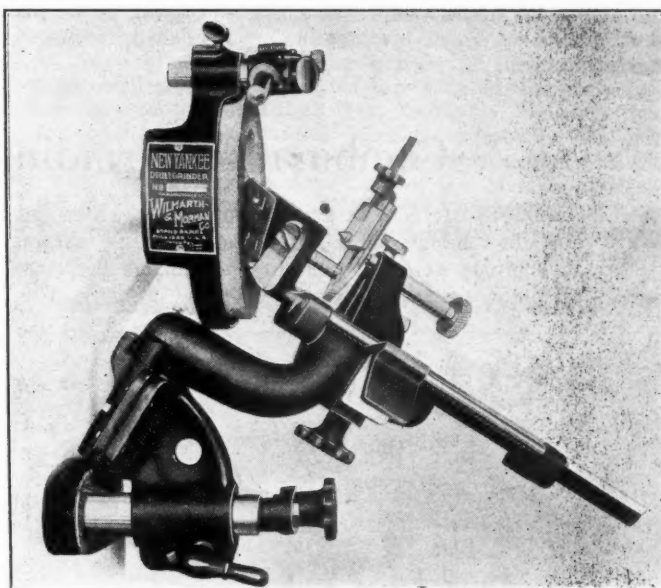


Fig. 3—Grinding a Short Straight Shank Drill

On account of the voluminous amount of drilling work in railway shops, twist drill grinders are an essential part of the toolroom equipment. The shop managements should not be content, however, to operate old style grinders when grinders with improved attachments are available. Especially when these attachments make possible a more accurate grinding of drills or when they allow for the grinding of short taper, or collared shank drills which would otherwise have to be ground by hand they should be installed. The aggregate saving due to their use will in the long run pay big dividends on the money invested.

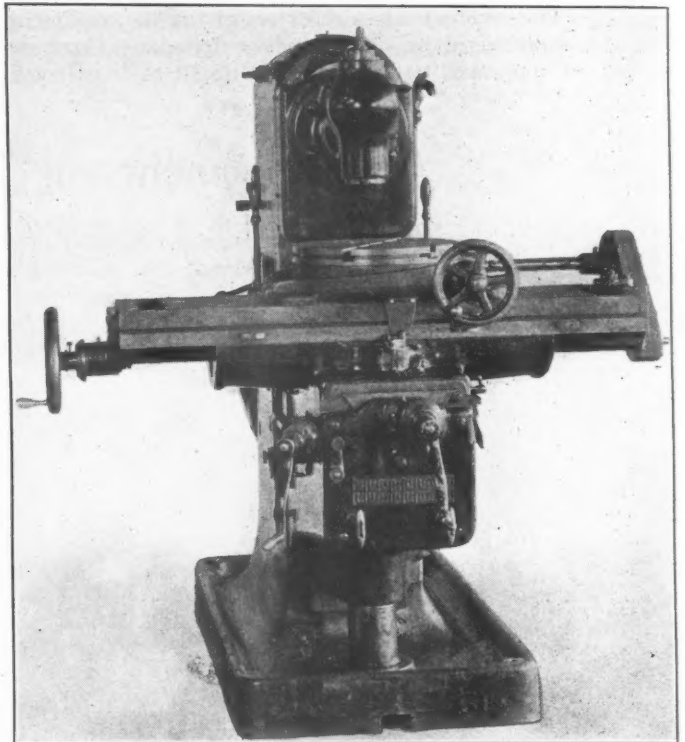
It is obvious that a shop or roundhouse so small as to require only the occasional use of twist drills could not afford the installation of a twist drill grinder, but in most cases the drilling requirements are large. Many drills of all different kinds and sizes have to be maintained in good working condition and, with the obvious inefficiency of hand grinding, the use of modern, improved twist drill grinders is advisable.

Rotary Table for Milling Machines

THE rotary table as designed for Cleveland milling machines, made by the Clark-Mesker Company, Cleveland, Ohio, can be operated either by hand or power feed. There are sixteen changes of feed, controlled from the front of the knee in the same way as the other feed movements of the table. The direction of rotation may be reversed by using the feed reverse lever in front of the knee. The feed drive is taken from the table feed drive gear, connected by telescopic sleeves to a gear case on the end of the table. From this point a shaft extends and drives a pair of bevel gears which drive the work shaft. The worm is cut with a coarse pitch and runs in oil. The end thrust is taken care of both ways by large ball thrust bearings and means are provided for taking up the wear.

The worm wheel is accurately cut and is made sufficiently large to allow heavy cuts to be taken on the circumference of the table. The rotary table is liberally provided with T-slots of the same size as those in the milling machine table. An automatic trip for releasing the power feed at any desired point is provided. The circumference of the table is graduated in degrees for obtaining angular settings. The table has a tapered center hole to accommodate a short taper arbor for centering gears and other work as well as for clamping the work.

This rotary table attachment may be used for cutting large gears, sprockets, etc., or it may be used for dividing, when furnished with a crank and index plates. Index plates and crank, however, are not regularly furnished with the attachment.



Rotary Table Applied to Cleveland Milling Machine

Combination Grinding and Buffing Machine

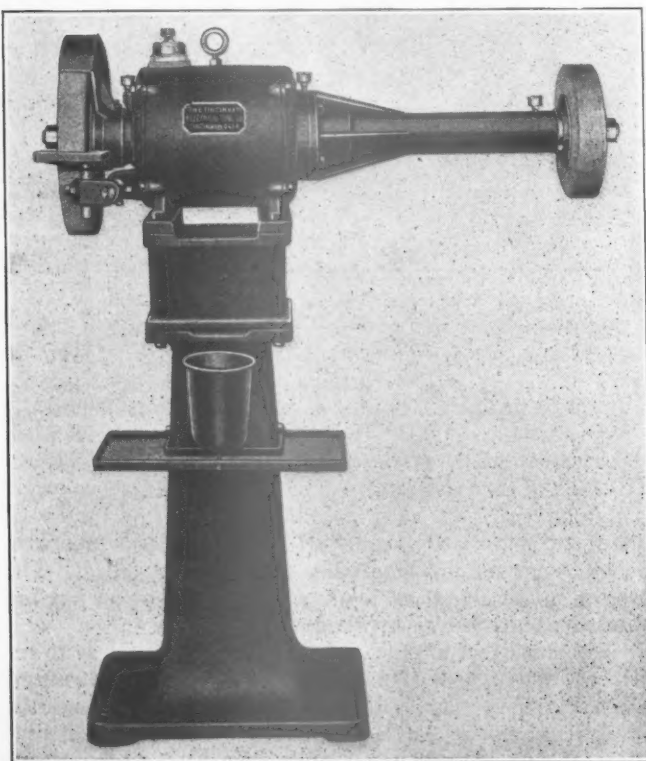
A COMBINATION floor grinder and buffer which permits interchangeable buffing and grinding without the common delay of changing wheels, is the latest product of the Cincinnati Electrical Tool Company, Cin-

cinnati, Ohio. The new machine is arranged with both grinding and buffing wheels, the grinding wheel being adapted to tool grinding and general grinding on all kinds of miscellaneous work.

The motor windings are fully enclosed and protected and spindles are carefully ground. Annular ball bearings are fitted on both ends of the armature spindle, as well as the end of the extension spindle. Dust caps, fitted to the spindle, protect the bearings and windings from emery dust and dirt, thereby increasing the life of the machine.

The grinders are fully equipped, including tool board and water pot, and can be furnished without floor pedestal if desired.

The motors are made for direct or alternating current in $\frac{1}{2}$, 1, 2 and 3 h.p. capacity to carry wheels from 8 to 14 in. in diameter.



Cincinnati Combination Grinder and Buffer

Change in Safe End Taper

The Coleman tube safe end, as described on page 127 of the February *Railway Mechanical Engineer*, is shown to be held against movement towards the firebox by a square shoulder and against movement in the other direction by a taper end, beaded over. The taper, indicated, was $2\frac{1}{4}$ in. per ft. but experience shows that this amount is greater than necessary and a taper of $1\frac{1}{2}$ in. per ft. has been adopted as standard.

Attention is also called to the statement on page 128 that the Coleman safe end requires about 10 per cent less working than the prossered safe end. In reality this should read 90 per cent less since the original statement was that Coleman safe ends require about 10 per cent of the working necessary with prossered safe ends.

Railway Mechanical Engineer

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WE GUARANTEE, that of this issue 9,200 copies were printed; that of these 9,200 copies, 8,253 were mailed to regular paid subscribers, 8 were provided for counter and news company sales, 265 were mailed to advertisers, 32 were mailed to employees and correspondents, and 642 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 40,200, an average of 10,050 copies a week.

The *Railway Mechanical Engineer* is a member of the Associated Business Papers (A. B. P.) and the Audit Bureau of Circulations (A. B. C.)

Fire, early on the morning of February 16, destroyed a two-story shop building of the Missouri Pacific at St. Louis, Mo.; estimated loss, \$100,000.

Senator Cummins, chairman of the Senate committee on interstate commerce, announces that he proposes to introduce at the beginning of the next session of Congress a bill providing for the compulsory consolidation of the railroads into 14 to 18 systems.

Eight thousand is the number of members of the National Safety Council who own or operate shops or other industrial plants; and the officers of the council propose to proprietors to conduct intensive campaigns, for some particular feature of safety, in all of these plants during one month throughout the year; a month to each feature. January was devoted to special efforts to prevent ladder accidents; February to infections arising from minor injuries, and March to unsafe clothing. For April the program is horse play.

Senator La Follette's speech in the Senate on February 21 and 22 in opposition to the passage of the Winslow bill has just been published in the Congressional Record, and, with the appendices, takes 64 pages, mainly in small type. The appendices consist largely of charts showing interlocking directorates and various statements presented by the labor leaders to the Railroad Labor Board at Chicago in connection with their charges that railroads have paid extravagant prices for car and locomotive repairs in outside shops.

A bulletin issued by the Bureau of Labor Statistics of the United States Department of Labor on employment in selected industries in January, 1921, summarizes reports from 46 car building and repairing establishments which in January, 1921, had on their payrolls 44,613 employees, or 5½ per cent less than for January, 1920. The amount of the payroll in January, 1921, however, was \$3,125,082, or 9.6 per cent greater than that for January, 1920. A similar comparison for January, 1921, and December, 1920, is given for 45 establishments, which shows a decrease of 12.4 per cent in the number of employees on the payroll and a decrease of 20.2 per cent in the amount of the payroll. The bulletin states that the industry reports that in order to reduce expenses and on account of the general business conditions the number of employees was reduced. The per capita earnings for the period in January were 8.9 per cent lower than for the December payroll period.

R. V. Massey, chairman of the newly organized joint reviewing committee of the Pennsylvania Railroad, says that the committee already has successfully disposed of, to the satisfaction of both sides, eight controversies which have been pending a

long time, one of them since 1914. To emphasize the fact that the committee is a united non-partisan body for the judicial and impartial settlement of differences and not a mere conference between representatives of opposing sides, it has been decided that at the meetings no two representatives of the management or of the employees shall be seated together, but that they shall be alternated around the table. Mr. Massey is "confident that every member of the committee, whether representing the men or the management, is keenly alive to the responsibility resting upon him; and equally confident that not one of the committee has the slightest doubt of the ability of this body to adjust on a fair and friendly basis any differences which may arise affecting the employees represented."

Inspection of Railway Stationary Boilers in Canada

The Board of Railway Commissioners for Canada has ordered that the railway companies subject to its jurisdiction put in force not later than June 1, 1921, regulations promulgated by the board for the inspection of railway steam boilers other than locomotive boilers. The orders cover the design and construction of the boiler and appurtenances and provide for periodical inspection.

Boiler Inspection Act Does Not Apply to Locomotive Cab

The New York Appellate Division holds that the Federal Boiler Inspection Act, requiring locomotive boilers and appurtenances to be kept safe, does not apply to a locomotive cab, so that sections 3 and 4 of the Employers' Liability Act, precluding the defenses of contributory negligence and assumed risk, where a safety act is violated, do not deprive the railroad of these defenses in an action for injuries caused by a depression in the floor of the cab. A cab is not appurtenant to a boiler, and the intention of the act was to guard against accidents peculiar to boilers.—*Brown v. L. V.*, 191 App. Div. 691, 181 N. Y. Supp. 800.

No Exhibits at June Conventions

The Railway Supply Manufacturers' Association at a meeting of its executive committee at Pittsburgh, Pa., voted against having an exhibit at the convention of the American Railway Association, Division V—Mechanical—in June.

Further details relative to this decision are given in a letter sent to members of the association, dated March 10 and signed by J. D. Conway, secretary, and J. F. Schurch, president. The letter follows:

After a thorough canvass and study of the entire situation, both among the manufacturers composing this organization and the railroad executives, your executive committee has unanimously decided it the part of wisdom

and good business judgment to postpone the June, 1921, R. S. M. A. exhibit at Atlantic City for the following reasons:

1. We are all familiar with the present depression in railroad and general business and the attendant desire and demand to curtail expenditures in every possible direction to strengthen the existing financial situation with the prime motive of developing greater economy and efficiency in operation.

2. In the opinion of men of mature judgment in the manufacturing as well as the railroad fields we are confronted today with the serious situation of not knowing with any degree of certainty as to just when business conditions will improve. Many manufacturing concerns engaged in the production of railroad devices and specialties are either shut down or running at an unusually low rate of operation.

While we realize this action is drastic, we feel that present conditions demand it. We are confident, however, that it will meet with the full approval of the business interests of the country, and we further believe that the future will warrant our resuming plans at a later date for the 1922 exhibit as in former years.

The executive committee also decided that it would not be necessary, in view of the cancellation of the exhibit and the annual meeting, to send representatives to such meetings of the Railroad, Mechanical and Purchases and Stores divisions, A. R. A., as may be held. The wisdom of cancelling hotel reservations was also suggested.

Mechanical Division of A. R. A. to Meet in Chicago

The General Committee of the Mechanical Division of the American Railway Association at a meeting in New York on March 30 decided to hold a business session at the Hotel Drake, Chicago, on June 15 and 16 instead of the convention that was to have occurred at Atlantic City. The program has been modified and reports will be presented only by the committees on the following subjects: Prices for Labor and Material, Car Construction, Loading Rules, Brake Shoe and Brake Beam Equipment, Train Brake and Signal Equipment, Specifications and Tests for Materials, Tank Cars and Standard Methods of Packing Journal Boxes. Both morning and afternoon sessions will be held while the division is meeting.

Locomotives to Be Built in Poland

It is stated by the Warsaw correspondent of the London Times that with the object of encouraging home industries the Polish government has recently signed contracts with a number of manufacturers in Poland for the delivery of large quantities of rolling stock for the Polish railways within the next 10 years. The firms chiefly concerned are the Polish Locomotive Works, Sosnowice, which has received an order for 1,100 locomotives; Lilpop, Rau & Lowenstein, Warsaw, which has received an order for 1,000 locomotives, 20,000 freight cars and 3,000 passenger cars; and the Ostrow Wagon Works, which has received an order for 18,000 freight cars and 2,800 passenger cars. None of these firms are in a position to carry out these orders with their present plants. The Polish Locomotive Works does not at present build complete locomotives, although it manufactures locomotive boilers. Neither has the Lilpop, Rau & Lowenstein plant built locomotives previously. The Ostrow Works is an entirely new enterprise and its factory is still in course of construction. Obviously these firms will need foreign capital and machinery to enable them to complete their orders.

Charges of Shop Unions Renewed

Five additional organizations of shop employees and the Railway Employees Department of the American Federation of Labor have joined with the International Association of Machinists in the complaint filed with the Interstate Commerce Commission requesting an investigation of railroad car and locomotive repair work. The original complaint was filed January 8, 1921, by W. Jett Lauck, representing William H. Johnston, president of the machinists. The press notice, just issued by way of keeping the subject alive, says that since the filing of the original complaint additional investigations have been made and the employees now claim to be prepared to fully substantiate all the charges made. The union heads who have joined with the Machinists' Association in the complaint, and the organizations which they represent, are as follows: B. M. Jewell, president of the Railway Employees Department, American Federation of Labor; J. J. Hynes, international president of the Amalgamated Sheet Metal Workers' International Alliance; Martin F. Ryan, general president of the Brotherhood of Railway Carmen of America; James P. Noonan, international president of the International Brotherhood of Electrical Workers; J. W. Kline, president of the International Brotherhood of Blacksmiths, Drop Forgers and Helpers of America; J. A.

Franklin, president of the International Brotherhood of Boilermakers and Iron Shipbuilders.

Employee Educational Work on the Great Northern

To meet a desire expressed by a number of employees, particularly in the engineering department, for an opportunity to acquire a broader knowledge of railroading than comes to them through the routine work of their own departments, the Great Northern is developing a course of study to be taken up at bi-monthly meetings, in St. Paul, of a class of several hundred employees. The course is designed to cover a period of about six months and the class is open to employees of all departments who are interested.

The extent of the interest is indicated by the fact that over 400 employees responded to the call for the first meeting. Interest in the plan is also developing among employees at outlying points and consideration is being given to means of extending it. This work had its inception among employees and officers at the headquarters of the road at St. Paul. Consideration is also being given to the development of a course of study that will meet the special requirements of interested employees in the mechanical department.

Retrenchment

Further extensive reductions of forces by the Pennsylvania Railroad were reported on February 26, at Altoona, Pittsburgh and other points. The operation of the Pittsburgh Terminal as a separate division is to be discontinued and the old division boundaries will, in general, be restored.

The Delaware, Lackawanna & Western has ordered further reductions in forces at the Scranton shops. The Union Pacific on February 26 ordered further extensive reductions in its shops. On the New York Central, large numbers of men returned to work in the shops at Collinwood, Ohio; Elkhart, Ind., and other points, after forced vacations of one or more weeks.

The Canadian National, following the severe falling off in business throughout large sections of Canada, has taken off some passenger trains in New Brunswick, including trains No. 31 and No. 32 between Moncton and Levis. In the western part of Ontario considerable numbers of men have been dismissed and two divisions have been consolidated into one.

Two hundred men in the shops of the New York, Ontario & Western at Middletown, N. Y., resumed work on March 1 after a layoff of a month.

Freight Cars

THE LOUISIANA & ARKANSAS has ordered 25 Hart convertible dump cars from the American Car & Foundry Co.

THE TIENSIN-PUKOW has ordered 300 40-ton all-steel gondola cars through Mitsui & Co., 65 Broadway, New York, from the American Car & Foundry Co.

Locomotives

THE IMPERIAL JAPANESE GOVERNMENT RAILWAYS is having 30 locomotives built in Japan.

THE PEKING-HANKOW has ordered 30 Prairie type locomotives from the Baldwin Locomotive Works.

THE LOUISVILLE & NASHVILLE will build 34 locomotives, including 16 Mikado type locomotives, in its own shops.

Shop Construction

LIVE OAK, PERRY & GULF.—This company has begun the reconstruction of its blacksmith and car shops at Live Oak, Fla. The buildings will be of frame construction, 50 ft. by 60 ft. and 60 ft. by 150 ft., respectively. The following new machinery will be purchased: planer, shaper, drill press and wheel press.

LOUISVILLE & NASHVILLE.—This company has awarded a contract to H. W. Hancock, Louisville, Ky., for the construction of a roundhouse and shops at Loyall, Ky., at an approximate cost of \$150,000.

ANN ARBOR.—This company will replace its woodworking shop at Owosso, Mich., recently destroyed by fire, with a steel fabricated building.

NORTHWESTERN PACIFIC.—This company will erect temporary structures to replace the machine shop, wood working mill, car repair shop and minor buildings which were destroyed by fire at

Tiburon, Cal., as definite decision has not been made as to whether a modern shop will be constructed at that point, or some more advantageous location along the line.

ATCHISON, TOPEKA & SANTA FE.—This company has authorized the construction of a blacksmith shop at San Bernardino, Cal., with dimensions of 80 ft. by 306 ft., to cost \$107,000. The company will also build a lavatory building at Needles, Cal., to cost \$22,500.

MEETINGS AND CONVENTIONS

The American Railway Tool Foremen's Association will hold its eleventh annual convention at the Hotel Sherman, Chicago, on August 9, 10 and 11.

The American Society for Steel Treating will hold its 1921 convention and exhibition at Indianapolis, Ind., on September 19 to 24 inclusive. The exhibition will be in the Manufacturers' building at the State Fair Grounds which will provide a floor space of 76,800 sq. ft., and the meetings will be held at the Women's building, which is located a short distance from the exhibition hall, where three or four large rooms will make it possible to hold sectional meetings simultaneously.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

- AIR-BRAKE ASSOCIATION.**—F. M. Nellis, Room 3014, 165 Broadway, New York City. Annual convention May 3 to 6 inclusive, Hotel Sherman, Chicago.
- AMERICAN RAILWAY ASSOCIATION, DIVISION V—MECHANICAL.**—V. R. Hawthorne, 431 South Dearborn St., Chicago. Next meeting June 15 and 16, Hotel Drake, Chicago, Ill.
- DIVISION V—EQUIPMENT PAINTING DIVISION.**—V. R. Hawthorne, Chicago.
- AMERICAN RAILWAY ASSOCIATION, DIVISION VI—PURCHASES AND STORES.**—J. P. Murphy, N. Y. C., Collinwood, Ohio. Second annual meeting June 20-22, Atlantic City, N. J.
- AMERICAN RAILROAD MASTER TINNERS', COPPERSMITHS' AND PIPEFITTERS' ASSOCIATION.**—C. Borchardt, 202 North Hamlin Ave., Chicago. Convention September 12-14, Hotel Sherman, Chicago.
- AMERICAN RAILWAY TOOL FOREMEN'S ASSOCIATION.**—R. D. Fletcher, 1145 E. Marquette Road, Chicago. Convention August 9, 10 and 11, Hotel Sherman, Chicago.
- AMERICAN SOCIETY FOR TESTING MATERIALS.**—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa.
- AMERICAN SOCIETY OF MECHANICAL ENGINEERS.**—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Spring meeting May 23 to 26 inclusive, Congress Hotel, Chicago.
- AMERICAN SOCIETY FOR STEEL TREATING.**—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio. Annual convention September 19-24, Indianapolis, Ind.
- ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS.**—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago.
- CANADIAN RAILWAY CLUB.**—W. A. Booth, 131 Charron St., Montreal, Que. Next meeting April 12. A paper on Some Side Light on Railway Time Tables will be presented by A. Hatton, general superintendent transportation, Canadian Pacific, Montreal.
- CAR FOREMEN'S ASSOCIATION OF CHICAGO.**—Aaron Kline, 626 N. Fine Ave., Chicago. Meeting second Monday in month, except June, July and August, New Morrison Hotel, Chicago.
- CAR FOREMEN'S ASSOCIATION OF ST. LOUIS.**—Thomas B. Koenke, 604 Federal Reserve Bank Building, St. Louis, Mo. Meetings first Tuesday in month at the American Hotel Annex, St. Louis.
- CENTRAL RAILWAY CLUB.**—H. D. Vought, 95 Liberty St., New York.
- CHIEF INTERCHANGE CAR INSPECTORS' AND CAR FOREMEN'S ASSOCIATION.**—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill.
- CINCINNATI RAILWAY CLUB.**—W. C. Cooder, Union Central Building, Cincinnati, Ohio. Meeting second Tuesday of February, May, September and November, Hotel Sinton, Cincinnati, Ohio.
- DIXIE AIR BRAKE CLUB.**—E. F. O'Connor, 10 West Grace St., Richmond, Va.
- INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION.**—W. J. Mayer, Michigan Central, 715 Clarke Ave., Detroit, Mich. Next meeting August 16, 17 and 18, 1921, Hotel Sherman, Chicago.
- INTERNATIONAL RAILWAY FUEL ASSOCIATION.**—J. G. Crawford, 702 East Fifty-first St., Chicago. Next annual meeting, May 24-26, 1921, Hotel Sherman, Chicago.
- INTERNATIONAL RAILWAY GENERAL FOREMEN'S ASSOCIATION.**—William Hall, 1061 W. Wabasha Ave., Winona, Minn. Convention, September 12, 13, 14 and 15, 1921, Hotel Sherman, Chicago.
- MASTER BOILERMAKERS' ASSOCIATION.**—Harry D. Vought, 95 Liberty St., New York. Convention, May 23 to 26, 1921, inclusive, Flanters' Hotel, St. Louis, Mo.
- NEW ENGLAND RAILROAD CLUB.**—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass. Next meeting April 12. Paper on Freight Claims—Their Cause and Prevention, will be presented by Charles M. MacDonald, freight claim agent, Boston & Maine.
- NEW YORK RAILROAD CLUB.**—H. D. Vought, 95 Liberty St., New York.
- NIAGARA FRONTIER CAR MEN'S ASSOCIATION.**—George A. J. Hochgrebe, 623 Brisbane Building, Buffalo, N. Y.
- PACIFIC RAILWAY CLUB.**—W. S. Wollner, 64 Pine St., San Francisco, Cal. Meeting second Thursday in month, alternately in San Francisco and Oakland, Cal.
- RAILWAY CLUB OF PITTSBURGH.**—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa. Meetings fourth Thursday in month except June, July and August, Americus Club House, Pittsburgh.
- ST. LOUIS RAILWAY CLUB.**—B. W. Frauenthal Union Station, St. Louis, Mo. Meetings second Friday in month, except June, July and August.
- TRAVELING ENGINEERS' ASSOCIATION.**—W. O. Thompson, N. Y. C. R. R., Buffalo, N. Y.
- WESTERN RAILWAY CLUB.**—Bruce V. Crandall, 14 E. Jackson Boulevard, Chicago. Meeting third Monday each month except June, July and August.

PERSONAL MENTION

MASTER MECHANICS AND ROAD FOREMEN OF ENGINES

FRANK G. FISCHER, whose appointment as master mechanic on the Southern division of the St. Louis-San Francisco at Memphis, Tenn., was announced in the March issue of the *Railway*

Mechanical Engineer, was born on October 19, 1878, at Richmond, Va. He received a common school education and entered the employ of the Chesapeake & Ohio on February 1, 1895, as a machinist apprentice. After working at various places on the Chesapeake & Ohio and the Baltimore & Ohio Southwestern as a machinist and roundhouse foreman until July, 1903, Mr. Fischer was employed in the roundhouse of the St. Louis-San Francisco at St. Louis, Mo. He then served successively as general foreman at Chaffee, Mo.;

general foreman at Memphis; general foreman at St. Louis, and until his recent appointment was assistant master mechanic at Monett, Mo.

J. W. SMALL, formerly superintendent of motive power of the Seaboard Air Line, has been appointed superintendent of motive power and shops of the Cuba Railroad with headquarters at Camaguey, Cuba, succeeding M. B. McPartland, resigned to accept service with another company. Mr. Small was born on September 24, 1870, at Chatham, Ont., and was educated in the high schools of that city and at the Collegiate Institute. He entered railway service in 1887 as a machinist apprentice on the Northern Pacific. In 1892 he went to Pocatello, Idaho, as a machinist on the Oregon Short Line. The following year he went to Tacoma, Wash., as a machinist for the Northern Pacific. During the same year he entered the service of the

Southern Pacific as a machinist and served subsequently as gang foreman, roundhouse foreman, assistant master mechanic and master mechanic for that company. In 1906 he became superintendent of motive power of the Mexican lines of the Southern Pacific. In 1910 he went to the Kansas City Southern in a similar capacity and the following year became superintendent of motive power for the Missouri Pacific. The same year he went with the Sunset Central Lines (Galveston, Harrisburg & San Antonio, Houston & Texas Central, Morgan's Louisiana & Texas, Texas & New Orleans, etc.) as assistant general manager. In 1913 he was appointed superintendent of motive power of the Seaboard Air Line. During federal control Mr. Small served first as mechanical assistant to the regional director, Southern region, and later as mechanical staff officer to the regional director of the same region.



F. G. Fischer



J. W. Small

HARRY M. ALLAN, whose appointment as master mechanic on the Canadian Pacific with headquarters at Kenora, Ont., was announced in the March issue of the *Railway Mechanical Engineer*, was born on July 26, 1886, at Balderson, Ont., and attended the Balderson public schools and the Perth high school. In October, 1906, after serving his apprenticeship with the Canadian Atlantic at Ottawa, Mr. Allan entered the employ of the Algoma Central at Sault Ste. Marie, Ont., and in March, 1907, resigned, and went from Fort William to Winnipeg and on to Moose Jaw, Sask., where he worked as a machinist for the Canadian Pacific. In 1910, he was promoted to shop foreman and from 1913 until his appointment as mentioned above, he was locomotive foreman in the Alyth roundhouse at Calgary, Alta.



H. M. Allan

CAR DEPARTMENT

ANDY J. LITWIN, car foreman on the Northern Pacific at Paradise, Mont., has been transferred to Staples, Minn., succeeding F. M. Weseman, deceased.

SHOP AND ENGINEHOUSE

W. ARTHUR BIRCH, freight gang foreman on the Atchison, Topeka & Santa Fe, at Needles, Cal., has been transferred to Barstow, Cal., to succeed E. O. Faulkner as roundhouse foreman.

H. D. EDDY, roundhouse foreman on the Atchison, Topeka & Santa Fe, at Needles, Cal., has been transferred to Bakersfield, Cal.

E. A. MURRAY, whose appointment as shop superintendent on the Chesapeake & Ohio, at Huntington, W. Va., was announced in the February issue of the *Railway Mechanical Engineer*, was born on September 1, 1876, at Staunton, Va. He received a public school education and on December 11, 1891, entered the employ of the Chesapeake & Ohio as a machinist apprentice. After completing his apprenticeship, he served successively as a machinist, locomotive fireman and gang foreman until 1903, when he was appointed general foreman. From 1909, until his recent promotion as above noted, Mr. Murray was master mechanic at Clifton Forge, Va.



E. A. Murray

GEORGE F. HEISE has been promoted to the position of tool-room foreman of the El Paso & Southwestern shops at El Paso, Tex.

PURCHASING AND STOREKEEPING

J. E. WHARTON, division storekeeper on the Pennsylvania, with headquarters at Toledo, Ohio, has been appointed storekeeper, maintenance of equipment department, with the same headquarters. The position of division storekeeper has been abolished.

SUPPLY TRADE NOTES

The R. G. Smith Tool & Mfg. Co. has moved from 315 Market street, into their larger factory at 245 N. J. R. R. avenue, Newark, N. J.

The H. K. Ferguson Company, southern department, has removed its offices to Room 218, Healey building, Atlanta, Ga. Richard W. Alger is the manager.

The Independent Pneumatic Tool Company, Chicago, has removed its Pittsburgh, Pa., office from 1208 Farmers Bank building, to 718 Bessemer building, corner of Fort and Duquesne Way.

Manning, Maxwell & Moore, Inc., New York, on May 1, will take over the merchandise and good-will of Patterson, Gottfried & Hunter, 211 Center street, New York. This firm handles mill and factory supplies.

Carl W. Bettcher has been appointed sales manager of the Eastern Machine Screw Corporation, New Haven, Conn. Mr. Bettcher was born on May 7, 1887, and graduated from the Boardman Manual Training School in 1904. He is also a graduate of Yale University, having completed the Sheffield Scientific course in 1907. The following two years he spent on the students' course at the General Electric Company at Lynn, Mass., doing principally testing work. He then entered the sales department of the Edison Lamp Works at Harrison, N. J., and after eight years of service with this company, became a captain of artillery in the United States Army and, for nine months of two years, was in active service in France. For the past two years he has been in the employ of the Eastern Machine Screw Corporation and will now specialize principally in the expansion of the sale of the H. & G. self-opening die heads.



Carl W. Bettcher

H. M. Pratt, manager of the branch office of the Southern Iron and Equipment Company at New Orleans, La., has been appointed general sales manager with headquarters at Atlanta, Ga. A. C. Wood succeeds Mr. Pratt at New Orleans.

The O'Malley-Beare Valve Company of Chicago has been appointed exclusive agent for the Chapman Valve Manufacturing Company of Indian Orchard, Mass., and will have charge of the sale of the Chapman lines of valves in the railway field in the United States.

The Southwark Foundry & Machine Company, Philadelphia, Pa., has opened a district office at 804 Swetland building, Cleveland, Ohio, under the management of its representative, Stewart Bolling, who has served for seven years as engineering salesman for this company.

The National Malleable Castings Company, Cleveland, Ohio, has bought the draft gear business, assets and good-will of the Butler Drawbar Attachment Company, Cleveland. The business of the latter company has been transacted for many years through the National Malleable Castings Company.

Harry L. Oviatt has been appointed traveling representative of the Armstrong Manufacturing Company, Bridgeport, Conn., manufacturers of pipe threading tools and taps. Mr. Oviatt has been with the Bullard Machine Tool Company, Bridgeport, for the past 13 years and during the last 3 years has been connected with the advertising department.

The Commonwealth Steel Company, St. Louis, Mo., has recently established an employees' benefit association, which provides insurance against sickness, accident or death for the employees. The company has offered to each member of its force a life insurance policy, varying in amounts from \$500 to \$2,000, depending on the length of service.

William C. Wilson, formerly connected with the Taylor-Wharton Iron & Steel Company and William Wharton, Jr., Company, in the capacity of manager of sales, northeastern territory, has become associated with the Pittsburgh Screw & Bolt Company, Pittsburgh, Pa. He will be located at its New York Office, 50 East Forty-second street.

The Power Equipment Company, 131 State street, Boston, Mass., has been appointed New England representative of the Conveyors Corporation of America, Chicago, for the sale of its American trolley carrier monorail conveying equipment, and Colwell & McMullin, 79 Milk street, Boston, are the New England representatives for its American steam ash conveyor.

The American Mason Safety Tread Company, 480 Lexington avenue, New York, has consolidated its general sales office for the New England States, New York State and New Jersey with the local New York City office, under the supervision of J. W. Scott. L. H. Devoe will continue to serve the trade in this territory as in the past, with headquarters at New York.

W. J. Roehl, formerly assistant purchasing agent of the Missouri Pacific, has been appointed sales representative in the St. Louis district for A. M. Castle & Co., Chicago, and has opened offices at 1946 Railway Exchange building, St. Louis. Mr. Roehl entered railroad business on May 4, 1906, as a clerk in the office of the supply agent of the Missouri Pacific and in May, 1910, was promoted to chief clerk. On March 1, 1913, he was promoted to chief clerk to the general purchasing agent and on June 1, 1918, became assistant purchasing agent.



W. J. Roehl

A. M. Castle & Co., in addition to their warehouse business in Chicago, are general distributors for the Rome Iron Mills' staybolt iron, the Lukens Steel Company's locomotive, flange and fire box steel; and the Detroit Seamless Steel Tubes Company's locomotive seamless boiler tubes.

The Liberty Car & Equipment Company and the Illinois Car & Manufacturing Company, both of Hammond, Ind., have been consolidated under the name of the Illinois Car & Manufacturing Company, with general offices at Hammond, Ind. The officers of the consolidated company are: P. H. Joyce, president; J. W. O'Leary, vice-president; J. F. Farrell, vice-president; J. E. Fitzgerald, treasurer, and O. R. Shearman, secretary. The plant at Chicago Heights is now known as the Liberty plant and the one at Hammond as the Hammond plant.

The Equitable Equipment Company, 411 Whitney Central building, New Orleans, La., has completed its organization for the purpose of handling locomotives, cars, railroad equipment, rails and rail accessories, machinery of all kinds, contractors' equipment and second hand machinery and equipment. This new company is taking over the equipment, rail and machinery business of A. Marx & Sons, Southern Scrap Material Company and the Ship Supply Company. The new firm will be under the direct management of O. D. Cleveland, who has been the manager of the New Orleans branch of the General Equipment Company.

Superheater Company

The election of three new vice-presidents is announced by the Superheater Company, New York, formerly the Locomotive Superheater Company. Gilbert E. Ryder, in charge of the service department, has been elected vice-president in charge of sales, with office at New York; Henry B. Oatley, chief engineer, has been elected vice-president in charge of engineering, with office at New York, and Charles H. True, works manager, has been elected vice-president in charge of production, with office at East Chicago, Ind.

Gilbert E. Ryder, vice-president in charge of sales, was born at Minneapolis, Minn., in 1880, and studied engineering at the University of Wisconsin, and also at the University of Illinois.



G. E. Ryder

His railroad experience began with an apprenticeship on the Chicago, Milwaukee & St. Paul, and included service as a journeyman in the mechanical department of that road at Dubuque, Ia.; Ottumwa, Ia., and West Milwaukee, covering five years. His engineering experience followed in the fuel testing bureau of the Technologic Branch of the United States Geological Survey. He later served the city of Chicago as deputy smoke inspector in charge of locomotives, which placed him again in contact with the locomotive fuel conservation problem.

This was followed by editorship of the Railway Review at Chicago, after which he entered the service of the Superheater Company ten years ago. He became a member of the service department and later took charge of that department. He also developed and had charge of the publicity department. Mr. Ryder takes responsibility of the sales of the company (railroad, stationary and marine), with an unusual preparation in wide and very valuable engineering and practical experience.

Henry B. Oatley, vice-president in charge of engineering, was born at Rochester, N. Y., and attended the public schools at that place. He received his engineering education at the University



H. B. Oatley

of Rochester and the University of Vermont, graduating from the latter in 1900 with the degree of mechanical engineer. He then entered the service of the Schenectady Locomotive Works, his experience while on this work embracing locomotive design and shop testing. He was associated with F. W. Cole in the early development of the superheater for locomotives by that company. In 1910, upon the formation of the superheater company, he was appointed mechanical engineer, and in 1916 he was appointed chief engineer for the

company, which position he held at the time of his election, as above noted. In April, 1917, he was granted a leave of absence and served as an officer in the U. S. Navy on the battleships Ohio and Indiana. He entered service with the 1st N. Y. Naval Militia, which was the first body of armed troops to move after the declaration of war with Germany. Mr. Oatley is a recognized authority on superheating and has been an active factor in its development. He is, in a large measure, responsible for putting superheater design upon a practical

operating and manufacturing basis in locomotive, marine and stationary practice, and, without sacrifice of efficiency, has developed uniformity of sizes and design.

Charles H. True, vice-president in charge of production, was born in Boston, Mass., and was educated at the public schools of Schuyler, Neb., and the University of Nebraska, graduating in 1898 with the degree of electrical engineer. Immediately upon graduation he entered the service of the Union Pacific at Omaha, and served in both the locomotive and car shops. In 1902 he became round-house foreman at Grand Island, Neb., and in 1903 resigned from the Union Pacific to take a similar position at Trenton, Mo., with the Chicago, Rock Island & Pacific. In October of the same year he was transferred to the Silvis shops as assistant superintendent of shops. In 1905 he was appointed mechanical engineer with the Railway Materials Company, at Chicago, and was engaged in the design of metallurgical furnaces for blacksmith shops and boiler shops, and in 1910 he refitted and took charge of the Phoenixville, Pa., plant of this company. Two years later Mr. True resigned his position with the Railway Materials Company to become works manager of the Superheater Company at East Chicago, which position he held until his election as vice-president, as above noted.



C. H. True

The Richmond, Va., office of the Vapor Car Heating Company, Inc., has been discontinued and all future business from the Southeastern territory will be handled from the offices of the company in Washington, D. C. The Washington office is in charge of Harry F. Lowman, who is assisted by L. B. Rhodes, Jr., previously connected with the sales department of the U. S. Light & Signal Corp. Mr. Rhodes, Jr., has been assigned to the Southeastern territory formerly handled by his father, L. B. Rhodes.

J. Brookes Spencer, assistant to first vice-president of the Southern Wheel Company, St. Louis, Mo., has been elected vice-president of the same company with headquarters at St. Louis. Mr. Spencer was born in St. Louis on January 15, 1888. He was educated at the Hill School, Pottstown, Pa., and was graduated from Yale University in the class of 1910. In 1917 he entered the service of the Southern Wheel Company at St. Louis and has been with the company since that time with the exception of a year when he served in the United States Army.

Keith J. Evans, advertising manager Joseph T. Ryerson & Son, was elected president of the Engineering Advertisers' Association at the annual meeting at Chicago on March 8. Mr. Evans has been with the Ryerson company for eight years, all of that time in the advertising department. Just prior to the entry of the United States in the war, Mr. Evans co-operated with Donald Ryerson, vice-president of the Ryerson company, who organized the "Four Minute Men" as a lobby in favor of military training. When war was declared, the organization was turned over to the Government and became a division of the Committee on Public Information. Mr. Evans was appointed national business manager, with headquarters at Washington, D. C., and served in that capacity until the organization was well under way, when he entered the army, becoming a second lieutenant in the field artillery. As advertising manager of the Ryerson company, Mr. Evans originated the 450-page loose leaf Ryerson steel service book, a very complete and handy current data book covering specifications and prices.

TRADE PUBLICATIONS

GAS PRODUCER.—"The Automatic Gas Producer" is the title of a 10-page booklet, illustrating and describing the construction and operation of automatic gas producers made by R. D. Wood & Co., Philadelphia, Pa.

CUPOLA USERS.—The Whiting Corporation, Harvey, Ill., has issued Bulletin No. 155, being a list of cupola users, arranged geographically and alphabetically under the various sizes of cupola. This bulletin supersedes No. 152.

FILTERS.—A 7-page bulletin, descriptive of the G-R multiscreen filter, has been issued by the Griscom-Russell Company, New York. This filter is a redesign of the well-known Reilly multiscreen feed water filter and grease extractor.

MACHINE TOOLS.—George Swift & Sons, Halifax, England, have issued a general catalogue of machine tools, illustrating and describing the line of radial drills, lathes, slotters, shapers and planers which are included in the regular line manufactured by this company.

PNEUMATIC TOOLS.—Circular No. 41, representing the latest achievements in the development of the pneumatic tool industry has been issued recently by the Keller Pneumatic Tool Company, Grand Haven, Mich. Specifications and a list of Keller made products are included.

IRON AND STEEL WORKERS' MACHINERY.—A representative type of each of the tools manufactured by the Scully Steel & Iron Company, Chicago, is shown in a 128-page catalogue which they have recently issued. A few details as to the size and capacity of each machine are given.

DUST COLLECTING AND CONVEYING.—Two 4-page bulletins, Nos. 12 and 501, have been issued recently by the Dust Recovering & Conveying Co., Cleveland, Ohio. These bulletins illustrate and describe the development of dust collecting equipment and pneumatic conveying respectively.

PORTABLE ELECTRICAL DRILLS AND GRINDERS.—The Cincinnati Electrical Tool Company, Cincinnati, Ohio, have recently issued a new catalogue covering their complete line of portable electrical drills, grinders and buffers, including several new type machines which they have recently brought out.

TAP DRILL SIZES.—A table of tap drill sizes for S.A.E. or A.S.M.E. machine tool standards has been prepared in pocket form by the Greenfield Tap & Die Corporation, Greenfield, Mass. Larger charts containing similar data and suitable for hanging in the shop for ready reference by the workmen, have also been brought out.

SANITATION AND WELFARE.—Bulletin No. 8 has been issued by the Bureau of Safety and Sanitation and Welfare of the United States Steel Corporation, New York, and contains 95, 8 in. by 10 in. pages devoted mostly to illustrations showing some of the things that have been done by the corporation and its subsidiary companies to improve the living and working conditions of employees.

REPAIR PARTS.—The Roberts & Schaefer Company, Chicago, has prepared a book illustrating all of their modern equipment for coal, sand and cinder handling on locomotives. Each unit of each machine is numbered according to the reference kept in the office of the company, making it comparatively easy for one to order spare or repair parts for mechanical devices for coal, sand and cinder handling.

TOOL BOOK.—The Goodell-Pratt Company, Greenfield, Mass., has recently issued tool book No. 14 containing 464 pages, 6 in. by 9 in. A detailed index of the fifteen hundred tools manufactured by this company is included in the front of the book, together with general information regarding design, making and inspection. List prices given in this catalogue were effective on January 1, 1920, and are subject to change without notice. For the convenience of mechanics and others who find the 6 in. by 9 in. book inconvenient to carry, a pocket edition with 3½ in. by 5½ in. pages is available.